FOLKLORE and ZOOLOGY

FLOE FOXON

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Folklore and Zoology

A scientific excursion into folklore, zoology, and cryptozoology, this text highlights a field, often called a pseudoscience, which seriously considers the possible existence of hidden or unknown animals not recognised in conventional zoology. *Folklore and Zoology* accessibly reviews the science of DNA samples; film and photograph analysis; hair and footprint examination; and the statistics behind such alleged animals as Sasquatch and the Yeti, Nessie and Champ, the Griffin and the Thunderbirds, and the possible survival of the thylacine, ivory-billed woodpecker, eastern cougar, and others. With over 400 references, *Folklore and Zoology* is among the most complete scientific review of cryptozoology to date, with discussion of the history and future, and successes and failures of this controversial and fascinating field, offering a fresh synthesis of a highly interdisciplinary literature. This book is ideal reading for students and academics interested in and studying zoology, palaeontology, and folklore courses.

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I wanted to read a book like this one, but couldn't find what I was looking for, so I decided to write it myself.
I am extremely grateful to:
John Acorn, Conservation Biologist, University of Alberta
Aaron M. Bauer, Zoologist, Villanova University
Christine Marie Janis, Paleontologist, Honorary Professor, University of Bristol, UK
Charles GM Paxton, Statistician and Fish Biologist, University of St. Andrews, UK
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I also thank my close acquaintances, who suffered through my frequent lectures on folklore & zoology.
I dedicate this work to Madame, the cat, who is neither big nor out of place, unlike the beasts in this book.
Finally, if you are moved by this book, I ask you to be more mindful of nature; the way things are going, we may destroy all of its mysteries before they can be solved.

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Forewords

John Acorn, Conservation Biologist, University of Alberta

Like Floe Foxon, I had a childhood fascination with cryptozoology. It all seemed so convincing at the time. I grew up with the classics: Nessie, Yeti, and Bigfoot.

Now, some might expect me to apologize for my youthful credulity, and blame it on the influence of "good stories", but to be honest, the stories weren't that well written. No, instead they were something else – they were compelling ideas. Where I grew up, the only local "cryptid" was Sasquatch, but the notion that one might come up from the river valley forests and peer into my bedroom window really put an edge on my early life.

These days, among other things, I teach about the nature of science; "a process that uses evidence and reason to figure out what exists, and how things work". Most scientists overlook the trickiness of "what exists" and focus on experiments instead. But "absence of evidence is still not evidence of absence" or so they say. Just ask the particle physicists, who seem truly baffled by the question of "what exists?" The result of all this is that every generation needs to be guided through this aspect of science anew.

And what is the answer? Parsimony. Period. It's the only way to judge such things.

Speaking of which, I don't believe in Sasquatch and more, but I'm intrigued by various other possibilities, including the continued, or very recent, existence of *Homo floresiensis*. This is why I agreed to write a short endorsement of this book and of Floe Foxon. Floe is indeed a careful scientific thinker, and his review of the cryptozoological field is both honest and humble. Plus, it contains some compelling ideas. I hope you enjoy it.

Aaron M. Bauer, Zoologist, Villanova University

Although dismissed by some as pseudoscience, cryptozoology, the study of unknown animals, is a legitimate field of scientific inquiry. Historically, the focus on some of the most unlikely cryptids, like giant hominids or lake monsters, has colored mainstream views of the field. However, the same rigorous analytical methods that are applied across the biological sciences in general can be and have been successfully employed both to debunk unsupported cryptozoological claims and to corroborate the existence or identity of creatures previously known from folklore or fragmentary physical evidence.

I inadvertently became a cryptozoologist in the 1980s when I described a giant gecko known from a single incomplete specimen and seemingly corresponding to an animal reported in Maori folklore. Nearly 40 years later, high-throughput sequencing of its DNA has now filled in many of the gaps about its origin and identity. At its best, cryptozoology can be a fine example of the integrative approach to zoology — combining morphology, genetics, and other core biological data, with historical, anthropological, archeological, and folkloric sources to evaluate unknown phenomena.

In *Folklore & Zoology*, Floe Foxon takes a balanced approach to reviewing cryptozoology as a discipline, from the more sensationalistic claims and unlikely explanations that keep cryptids in the public eye, to serious attempts to bring legitimacy to the field. This concise book uses selected examples to highlight the scope and appeal of cryptozoology and introduces inquisitive readers to its strengths, weaknesses, successes, failures, and future. Given the apparent human need to find explanations for the unknown, it seems that cryptozoology is here to stay. Whether it remains on the fringes of credibility or can serve as an inspiration or even a tool in mainstream systematics and conservation biology remains an open question.

Christine Marie Janis, Paleontologist, Honorary Professor, University of Bristol, UK

This book was a wonderful trip down memory lane for me, bringing back the days of my active involvement in the International Society for Cryptozoology and my friendship with its founder, the late Richard Greenwell, who died long before his time. The book is a fascinating review of the literature on cryptozoology, with an extensive list of references comprising almost a third of the text. It covers not only the classic cryptids, such as Sasquatch and the Loch Ness Monster, but also allots much attention to other kinds of "unknown animals" listed taxonomically, including Lazarus taxa (formerly thought to be extinct, such as the coelacanth), living animals originally known from folklore (such as the okapi), possibly still extant animals of dubious provenance (such as the thylacine and the ivory-billed woodpecker), extinct animals known from archaeological artifacts (such as the sivathere giraffid), and sightings of "mysterious beasts" (such as various lake monsters and big cats).

The approach of this book is of particular interest: it is neither credulous nor overly cynical, but documents the various cryptid critters in an informative and dispassionate manner. For example, the discussion of the various reports of large, unknown primates, including DNA analysis of supposed hair sample, does not pass judgement on the likelihood of their existence, but does rather coolly point out that sightings of such animals only occur in places where bears are also known to exist. Perhaps they just share the same habitat, or perhaps – ? Well, just perhaps. Who knows?; we (or at least many of us) love a mystery, and this book does not try to burst any bubbles but lets the readers come to their own conclusions. I found it a delightful and refreshing inventory.

Adrian Shine, Naturalist, Loch Ness Project

Folklore & Zoology is a new and concise way of looking at a subject first introduced by Bernard Heuvelmans nearly 70 years ago. Heuvelmans, in his books on "hidden animals", both on land and at sea, argued for rigour in the search and study of such animals. In this, he hoped to see the subject become a scientific branch of zoology. Thus, was cryptozoology born, and on those terms, it is difficult to see why it should be particularly controversial among naturalists, many of whom would now regard it as "pseudoscience". The problem is that much of the 'evidence' in cryptozoology is human witness testimony which science terms 'anecdotal'. Subsequent to Heuvelmans, cryptozoology has also suffered from association with the paranormal, young Earth creationism and has even been done no favours by some of its 'poster' favourites such as the Loch Ness Monster and Bigfoot. Even I tend to characterize cryptozoology more as a 'movement' generated by the 1960s postmodernist challenge to convention.

Floe Foxon, in this wide ranging but concise account, details many of the above difficulties and is particularly helpful to the general reader in clarifying the conventional process of species description. However, he also points out that human observation lies at the root of many scientific discoveries. He is even able to bring examples of the (admittedly controversial) introduction of a hitherto cryptozoological method, namely photography, to the conventional description of species. There are examples, too, of zoological discoveries certainly made with the aid of anecdotal evidence. And it is here, in the description and reference to method that I think the main value of the book lies. Foxon remains unbiased and clearly committed to the rigour which Heuvelmans hoped for. Here, in one place, is a review of the entire field of suggested 'hidden animals' but meticulously punctuated with references to what investigators have actually done in the field and argued on paper. I have learned a lot from it.

1

Introduction

This book concerns the intersection between folklore and zoology, namely, cryptozoology, the field often considered a pseudoscience that seriously considers the possible existence of "hidden" or "unknown" animals not recognized in conventional academic zoology. To understand why the existence of these alleged animals is disupted, it is first necessary to describe how the discovery of new animal species takes place in conventional zoology.

Zoological taxonomy is the biological science through which animals are described and categorized. In this taxonomy, an animal species is formally described with a holotype. In general, the holotype is a physical specimen, often stored in an institutional collection, such as a museum, to allow for future examination. This evidential hurdle has ensured that zoology remains a strictly evidence-based study of nature, with little to no room for frauds or cases of mistaken existence.

At times, this process is controversial. In the last few decades, some species have been described based solely on high-quality photographs from reliable sources [22]. One such species, the ctenophore (comb jelly) *Duobrachium sparksae*, was observed north-northwest of Puerto Rico in 2015 with the remotely operated submersible *Deep Discoverer* [12]. The bee fly *Marleyimyia xylocopae* was similarly described with still pictures the same year [28]. However, photography-based taxonomy has been met with criticism; some 500 taxonomists and collection-based researchers have called for the rejection of this technique [7, 21].

Many animals and other organisms are still undescribed. Over two million extant species and over 460,000 extinct taxa are recognized by taxonomists [6, 8], but each year, hundreds to thousands of new species are catalogued, and perhaps ten million extant species and hundreds of millions of extinct species are still unknown to science [32, 37].

Occasionally, a species thought to be extinct is "resurrected" when it is discovered to be extant after all. Perhaps the most widely known example is that of the coelacanth (lobe-finned fish) *Latimeria chalumnae*. In 1938, this "living fossil" (a term attributed to Charles Darwin) was caught in an estuary in South Africa, discovered by East London Natural History Museum curator Marjorie Courtenay-Latimer [10], and formally described by ichthyologist James L.B. Smith [35, 36]. Hundreds of coelacanth specimens have been collected in the years since [38]; in 2019, a coelecanth upwards of two meters in size was filmed on the South Coast of KwaZulu-Natal [14]. Before this

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discovery, it was thought by some that the coelecanths had become extinct in the Cretaceous Period, over 60 million years ago.

A dozen or so other examples of "Lazarus" taxa are known. The Laotian rock rat *Laonastes aenigmamus* is a rodent native to the Lao People's Democratic Republic and the Socialist Republic of Vietnam. First described in 2005, it was later understood to be a surviving member of a rodent family otherwise extinct for 11 million years [11]. Indeed, this rock rat has been described as "the coelacanth of rodents" [5]. In 1846, the false killer whale *Pseudorca crassidens*, a large marine mammal, was described as an extinct species based on a single subfossil skull [33]. Fifteen years later, through the discovery of a recent carcass, the species was revealed to have survived [31]. More recently, the small bivalve mollusk *Cymatioa cooki*, presumed extinct for 40,000 years, was photographed by marine ecologist Jeff Goddard in 2018, after which a live specimen was collected and the species was formally described in 2022 [39].

When an animal is formally described, it passes from the realm of the scientifically unrecognized, into the realm of the scientifically recognized. Of course, all species were scientifically undescribed at one time. Therefore, just because an animal has not been formally described (or had its formal description accepted), does not necessarily mean that it does not exist, or that it is completely unknown. Indeed, some indigenous Comoran fishermen knew of the coelecanth (variously as "gombessa" or "ngombessa") before it was catalogued by Europeans, even using the bony scales of the fish as tools [38]. Similarly, Lao people knew of the Laotian rock rat as "kha-nyou" and sold specimens of these animals in local markets [11]. Thus, the coelecanth and rock rat are examples of "folk taxonomy" preceeding conventional zoological taxonomy.

It may be argued that, if conventional zoologists had sought out and investigated indigenous reports of as-yet undescribed animals, the discoveries of the coelacanth, Laotian rock rat, and others may have been accelerated by many years. Indeed, local knowledge was instrumental to the rediscovery of the black-naped pheasant pigeon, *Otidiphaps nobilis insularis*, of Fergusson Island off the coast of Papua New Guinea. This animal had not been documented since its formal description in 1882, and a search for the animal in 2019 resulted in failure. But, in 2022, an expedition co-led by ornithologist Jordan Boersma rediscovered the animal in an event which has been likened to "finding a unicorn or a Bigfoot" [30]. This method of using indigenous reports or traditional ecological knowledge as a basis for zoological investigation has been extended to mythical animals described in folklore.

Folklore has been viewed as the emotional expression of lived experiences [3] and has also been interpreted as a form of study of natural history. For example, some Greco-Roman myths and legends may have their origins in natural phenomena, mythicized for compatibility with religion. Mythologization may be a way of compensating for lack of true knowledge about a phenomenon, sometimes featuring projections of human psychology such as lust for treasure or flesh [18]. Folklorist Adrienne Mayor argues that, just as fossils are petrified

animal remains, folklore may be "petrified" knowledge of the natural world or paleontological legend [29]. Under these interpretations, folklore is a cultural memory, in that it contains historical accounts embellished over time through oral tradition. If folklore is interpreted under the axiom "myths and legends are the memory of people" [25], then folklore may be analyzed to separate the underlying reality or "memory" from the fictional components or "myth", that is, the signal from the noise. For example, "Great Flood" myths have been ascribed to natural (though somewhat less dramatic) flooding events [42], and the mythical waterfalls of the indigenous peoples of Bolivia, which are said to fall from the sky, have been ascribed to the Angel Falls of Auyán-tepui, the world's tallest (uninterrupted) waterfall [15]. More relevantly, numerous Native American traditions of large mammalian animals have been attributed to mammoths and other Pleistocene fauna [23], and anthropologist Gregory Forth [13] has put forward an ethnobiological interpretation of folklore on the Indonesian island of Flores, arguing that legendary hominoid traditions may stem from interactions between the human population of the island and non-human hominids in historical times. This does not, however, require *all* folkloric animals to exist or to have at one time existed [9].

The enormous number of extinct and extant species that remain to be catalogued, the surprising discoveries of living creatures thought previously to be extinct, and the tendency for some species to be known indigenously despite being considered extinct or not having been catalogued in conventional science, have generated much interest in so-called "hidden" animals [34].

In the 1950s, Bernard Heuvelmans, Ivan Sanderson, and others developed the field of cryptozoology ('hidden animal study') to rigorize research into hidden animals that lack formal zoological description. Heuvelmans defined cryptozoology as the systematized study of "still unknown animal forms about which only testimonial and circumstantial evidence is available, or material evidence considered insufficient by some" [19, 17], or more simply as "the study of hidden animals on scientific principles" [27]. Dmitri Bayanov of the Darwin Museum in Moscow proposed the alternative definition of cryptozoology as "[t]he collecting and scientific study of evidence for the existence of animals whose presence in general or in a particular time or place is not recognized by zoology" [2]. This extends the scope of cryptozoology to *known* animal forms whose existence in a given place or time is disputed, much to the chagrin of Heuvelmans [19]. Even more broadly, biologist and cryptozoologist Roy Mackal defined cryptozoology as "the investigation, analysis, publication, and discussion of all matters related to animals of unexpected form or size, or unexpected occurence in time or space" [27].

Cryptozoology was described by Huevelmans as the "sister science" to palaeontology, noting that while the latter is the science of organisms lost to time, the former is the science of organisms "lost" in space [16]. From 1982 to 1996, the International Society of Cryptozoology published the interdisciplinary scientific journal *Cryptozoology* to encompass these efforts and held meetings, talks, and symposia at the University of Chicago, New York

University, the University of British Columbia, the International Congress of Systematic and Evolutionary Biology, and elsewhere. The hidden animals of cryptozoolgy have been called "cryptozoids" [26], "cryptozoans" [24], and perhaps most popularly, "cryptids" [40], though by systematic zoology conventions the latter suggests members of the family "Cryptidae", which is not the intention [1].

Cryptozoologist J. Richard Greenwell defined a seven-level classification system of unknown animals [16].

I: Animals of known, extant taxa whose size, coloration, or pattern is unrecognized.

II: Animals of known, extant taxa whose purported habitat is unrecognized.

III: Animals of known, extant taxa, known only from incomplete specimens (e.g., tissue), whose species is unrecognized.

IV: Animals of known taxa, believed to have become extinct during historical times, whose existence in the present is unrecognized.

V: Animals of known taxa, believed to have become extinct during geological times, whose existence in the present is unrecognized.

VI: Animals of unknown (new) taxa, known only from non-specimen evidence, e.g., indigenous folklore, whose existence in the past and present is unrecognized.

VII: Animals of unknown (new) taxa, completely unknown to people, whose existence in the past and present is unrecognized.

These categories give rise to the concept of "ethnoknown", that is, something known to indigenous people that is not scientifically recognized, as opposed to being "science-known" [41].

Decades have been spent researching various ethnoknown animals within these categories. However, with the absence of holotypes and with the shift in popular cryptozoology toward the unscientific and even the supernatural, cryptozoology has been largely abandoned and is now generally associated with other such fringe fields as parapsychology and ufology. In 1998, the International Society of Cryptozoology dissolved, and many of its most senior members have since passed away.

In an attempt to restore the early scientific focus of cryptozoology, cryptozoologist Karl Shuker and the Centre for Fortean Zoology began the *The Journal of Cryptozoology* in 2012, which ran for four volumes. The Centre for Fortean Zoology has also published an (almost) annual yearbook since 1996. In 2016, the International Cryptozoology Society (ICS) was founded with ocean scientist Paul H. LeBlond of The University of British Columbia as its President. The ICS maintains the International Cryptozoology Museum

in Maine, which collects items of cryptozoological significance. Despite these more recent efforts, academic interest in cryptozoology has remained low.

While most in the scientific community remain skeptical, owing mainly to a lack of bones or other such specimens [20], popular belief in mystery creatures is substantial. In 2022, 13% of US adults surveyed expressed belief in Bigfoot, and 9% in the Loch Ness Monster [4]. Continued interest in such alleged animals may be attributed to many factors, including common references in media, and the "I want to believe" mentality. Indeed, beliefs in cryptids is a multi-millennia tradition, with sightings of relict species dating back to ancient Rome, where half-man, half-ungulate satyrs, and centaurs were reported to have been seen and captured [29].

The following chapters summarize a considerable portion of the scientific evidence, or lack thereof, pertaining to the hidden animals of cryptozoology, and cryptozoologically adjacent animals. In the second chapter, the mystery hominids Sasquatch and the Yeti are discussed. In the third chapter, "alien" big cats such as the Beast of Exmoor and the onza are explored. The fourth chapter delves into such flying species as the ivory-billed woodpecker, the thunderbirds, and the griffin. In the fifth chapter, the possible survival of other terrestrial animals including ground sloths and the thylacine are examined. Chapters six and seven investigate the lake "monsters" of Loch Ness and Lake Champlain, and sea creatures including the giant octopus and "serpents". In the eighth and final chapter, the successes and failures of cryptozoology, as well as its future direction, are discussed in summary. So begins an excursion into folklore and zoology.

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2

Primates

Perhaps the most famous (or infamous) speculative animals are the mystery hominids. The western gorilla, *Gorilla gorilla*, a large extant primate capable of bipedalism, was unknown to science until the 19th century, when in 1847, Thomas Savage and Jeffries Wyman published the first scholarly description of the animal [75]. Similarly, the eastern gorilla *Gorilla beringei* was formally described for science only in 1903, despite these animals having featured in "traveller's tales" for decades prior [36]. The scientific recognition of the gorilla was significant because it had evaded formal European discovery for centuries [13]. Proponents of unknown hominids hypothesise that if such large, man-like creatures could go so long unnoticed by conventional science, then others, still unknown, may also exist, awaiting discovery.

As faunal catalogues become increasingly systematized, it becomes increasingly less likely that other large, unknown mammals exist uncatalogued. However, relatively large megafauna recognized only since the 1990s include the saola *Pseudoryx nghetinhensis*, unknown to science until 1992 [80]; the Tapanuli orangutan *Pongo tapanuliensis*, described in 2017 [67]; and Rice's whale *Balaenoptera ricei*, described in 2021 [70]. Thus, room for new discoveries remains.

Of particular relevance is the kipunji monkey *Rungwecebus kipunji*, described only in 2003 [40]. This animal is important because its discovery was facilitated by the eyewitness testimony of the Wanyakyusa people, as well as circumstantial evidence such as audio recordings of its "honk-bark" calls. Both the holotype and paratype of this species were photographed but not collected. At that time, it was the first new monkey genus since 1923.

2.1 Sasquatch (or Bigfoot)

The Sasquatch ("wild man of the woods" or "hairy mountain men") is the West Coast First Nations peoples' tradition of a tall, hairy man or man-like animal, often attributed supernatural abilities and symbolism [9, 63]. Numerous accounts of similar animals have been recorded from the Lakota and Inuit people among others [38, 11], as well as more recent "sightings" of unknown animals across the US and Canada. Dozens of informal accounts between 1924

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and 1974 were collected by primatologist John Napier [63], and over 5,000 more reports are catalogued in an on-line database [3]. "Bigfoot" is commonly used to describe the same unknown animal.

FIGURE 2.1
Gorillas were well known to African peoples before being described for conventional zoological science, having evaded European discovery for four centuries. Photo of western lowland gorilla at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania by Floe Foxon.

While intriguing, the imperfect nature of eyewitness testimony is well documented, and testimony alone is not an evidential substitute for a holotype or equivalent evidence. The sheer number of Sasquatch reports is interesting, but does not rule out mistaken identity; a study with almost 2,000 participants witnessing a potentially distressing event, namely a mock crime, found that 81% could not correctly recall details about the event shortly thereafter [8]. Cryptozoologists will note that this leaves 19% of people who *could* correctly recall details about the event. Whether these statistics extrapolate to purported sightings of cryptids is not clear.

Testimony in the case of Sasquatch (and other such unknown animals) is complicated by many factors: the post-event misinformation effect, whereby memory is influenced by information learned after the event [52]; memory conformity, whereby post-event discussion between witnesses of the same event

influences the memory of each [69]; and reconsolidation, whereby frequently revisiting memories in one's mind may cause them to be disrupted [32]. These and other reliability concerns demand evidence beyond the anecdotal for scientific recognition of the Sasquatch.

The first physical evidence presented for the existence of Sasquatch were tracks and footprints, photographed and/or cast with gypsum plaster or similar material. While many alleged footprints have been presented (e.g., in [63]), their dimensions range considerably, and most do not contain dermatoglyphic detail, either because they are faked, or because they were made in material which does not preserve such detail.

Perhaps the most commonly cited example of alleged Sasquatch footprints are the "Walla Walla" footprints described by anthropologist Grover Krantz [45]. These large, human-like footprints made in loess soil, cast by US Forest Service personnel including wildlife biologist Rodney Johnson, appeared to shown both primate dermal ridge patterns, and evenly distributed holes along these ridges identified as sweat pores. Krantz [45] and other dermatoglyphics researchers and law enforcement personnel argued that these details (the "pores" especially) are practically impossible to forge, and therefore the footprints must be those of a yet-undiscovered animal. Another morphological feature of the prints, the sole pads, has been analyzed by physical anthropologist Susan Cachel [10] of Rutgers University, who suggested that the prints are authentic.

Krantz argued that these tracks constitute sufficient evidence (as type specimens) to assign the binomen *Gigantopithecus canadensis* to the alleged animal responsible [35]. In their defense, proponents of Bigfoot binomen point out that tracks and footprints have elsewhere been deemed sufficient evidence to ascribe taxa to extinct animals. For example, the ichnotaxon (based only on trace fossil) *Chirotherium* is thought to represent a pseudosuchian (crocodilian), and is known only by its tracks [83]. However, proponents fail to note that ichnotaxonomy, the taxonomy of ichnology, is partially distinct from the Linnaean taxonomy of zoology; although both are regulated by the International Code of Zoological Nomenclature (ICZN), traces of extant animals are excluded from the ICZN. Paleontologist Walter Häntzschel notes that "with the trace fossils the meaning of "genus" differs much from that applicable to body fossils" [68]. Ultimately, *G. canadensis* was rejected as a *nomen dubium* (doubtful name) on the grounds that, even if the footprints were legitimate, there is insufficient evidence to link them to the extinct genus *Gigantopithecus*. Incidentally, the issue of validity of cryptozoological nomenclature within the context of ICZN is discussed by ethnozoologist Lorenzo Rossi [71], who notes from Dubois and Nemesio [22] that although the ICZN does not require registration of preserved specimens, it "categorically rules out all "hypothetical concepts", i.e., all those animals whose existence—past or present—is formally known only to the mind of the author."

A possible method of fabricating tracks such as those observed at "Walla Walla" is the latex-and-kerosene expansion method, which preserves

dermatoglyphic details from ordinary human feet while greatly expanding their size [1]. However, preservation of the original spacing of the dermal ridges using such an expansion method has been questioned [46]. Elaborate dermal ridges have also been replicated in experiments with human feet and modelling clay [5]. One laboratory replication study showed that the "pores" visible along dermal ridges may be artefacts of the casting process, namely cavities produced by air bubbles [26].

It has further been noted that some of the "Walla Walla" tracks were shallower than the bootprints of observers, and that some prints appeared to have been picked free of pebbles and needles prior to discovery [17]. Rather than certain authenticity or forgery, human biologist Robert J. Meier suggested taking a "scientifically sound middle course, one which opts for no decision at this time for lack of substantive evidence" [57].

Other evidence presented is photographic. Long before the camera was invented, people depicted animals, both real and imaginary, in petroglyphs. "Hairy man" pretroglyphs in the Tule River Tribe Reservation, approximately 1,000 years old, have been interpreted as pictorial representations of unknown hominids [81]. Other Native American petroglyphs depicting animals such as humanoid frogs, however, have not received such literal interpretations, which may indicate confirmation bias.

Arguably the "clearest" purported photographic evidence for Sasquatch is the Patterson-Gimlin film; 954 frames of 16 mm film shared in 1967, appearing to show a hairy, bipedal subject filmed in daylight in Bluff Creek, California, retreating from the camera and turning to observe the cameraman [62]. Initial reactions from scientists at a showing of the film were described as "tepid" [15], with some expressing doubt [96]. The personal characters of the film makers have been called into question [20], with some arguing that Patterson had the means, motive, and opportunity to fake the famous film [53]. Although discrepancies between the accounts of the two film makers have been noted, this may be expected due to the aforementioned reliability concerns with eyewitness recall, and therefore analysis of the film itself may be more pertinent to evaluating its legitimacy.

Various analyses of the Patterson-Gimlin film have been published. A study analyzing the integrity and quality of the film found no evidence of splicing or editing, with the resolution and focus as good as "one could expect for 16 mm film" [61]. Obviously, the film pre-dates modern digital effects. Some researchers have attempted to analyse the kinesiology of the subject [47], but these were typically based on the original "shaky" footage and therefore may not be reliable. More recently, software-enabled stabilisations of the film have been published [18], in which the subject's movement is not dissimilar to human kinesis. The kinematics of the subject have also been studied [29], but these are uncertain because the exact frame rate of the film is unknown (though 18 frames per second is probably a reasonable estimate [62]). A "perspective-matching" study compared lidar scans of the film site to frames of the film in order to quantify the height of the subject [41, 21]. The height

was estimated at six feet and three inches, which is taller than 95.8% of men age 30–39 in the USA [91], and is far lower than previous estimates exceeding seven feet [29]. Daegling and Schmitt concluded that "it is not possible to evaluate the identity of the film subject with any confidence" [16].

Besides video recordings, audio recordings of vocalizations allegedly made by Sasquatch have been analyzed. Statistical analysis of pitch and vocal tract length estimates for sounds on a purported Sasquatch tape recording from California in 1972, showed that many of the sounds were within the approximate 95% probability region for an average human male [44]. Those outside this region were estimated to be made by a man-like animal (or indeed, a man) with height from six feet and four inches to eight feet and two inches, though pre-recording with subsequent manipulation in playback could not be ruled out entirely.

Hairs and other bodily material purportedly taken from unknown hominids have also been presented and analyzed. Declassified FBI documents describe transmitted and incident light microscopy analysis of alleged Bigfoot hairs submitted to the agency in 1976 [24]. The morphological characteristics of these samples were matched to cervids (deer).

In a similar study, biologists and anthropologists Bryant and Trevor-Deutsch [7] examined three hair specimens and five faeces specimens of reported Sasquatch origin. Of the hair samples, one was identified as domesticated cattle *Bos taurus*, one as black bear *Ursus americanus*, and one remained unidentified. Of the faeces samples, two were large, unsegmented masses characteristic of cattle, one resembled owl pellet, and the remaining two were unidentified.

On other occasions, physical and morphological analysis of alleged Sasquatch hairs with microscopy, melting-point measurements, and determination of solubility, revealed these "hairs" to be synthetic fiber [93, 77].

Attempts have also been made to identify genetic material belonging to unknown hominids. In one of the first such studies, a tuft of supposed Sasquatch hair was collected following a sighting in Yukon, Canada, supplemented by a footprint [12]. 99–100% sequence identities were found in the American bison *Bison bison*.

Controversy arose in 2012 when a genetic research manuscript authored by members of the Sasquatch Genome Project (including bioinformaticians, molecular biologists, clinical pathologists, and forensic scientists) was rejected for publication by the peer-reviewed journals *Nature* and *PLOS One* (the former following two rounds of review, and the latter without review). In the study, over 100 purported Sasquatch blood, hair, and tissue samples underwent nuclear and mitochondrial DNA sequencing, among other analyses [43]. The authors reported that the samples yielded human DNA "interspersed with sequence that is novel but primate in origin", suggesting a new subspecies with trinomial nomenclature *Homo sapiens feralis*.

Issues with the study methodology and interpretation of results were raised in peer review [72, 73]. Complete genomes were not generated for the first

draft. In revisions, the authors describe obtaining complete genomes through a third party whose methods were proprietary, and therefore unclear. The mtDNA data were homologous to ordinary *H. sapiens* mtDNA, and the haplotype and haplogroup attributions fit within *H. sapiens* phylogeny. Thus, the suggestion of an undescribed species was not well justified. While the nuDNA data did appear to contain novel sequences, these may be explained by PCR artefacts, resulting from contamination or DNA degradation. A Basic Local Alignment Search Tool (BLAST) search of GenBank produced no matches for the material studied, which may further indicate contamination. The authors also performed electron microscopy "as supporting evidence for the unusual behavior of the amplified DNA," but the structural differences observed are also explained by DNA damage. Finally, the forensic hair analysis was not well described or referenced, and therefore may have been subjective.

The article was ultimately self-published in the inaugural issue of *DeNovo: accelerating science* journal. Just one other article [42] was published in *DeNovo* before the journal became defunct. As supplemental evidence, the authors of the *DeNovo* article provided video footage from the "Erickson Project', which purportedly depicts a subject, dubbed "Matilda", from which hair samples were taken [74]. "Matilda" has been likened to the commercially available costume of an ape-like character from a popular science fiction series [48].

In a re-analysis of the *DeNovo* article data, chemist Haskell Hart [34] demonstrated that the Ketchum nuDNA sequences all match known species of mammals in GenBank. Hart [33] further notes that studies aspiring to assess DNA as evidence for the existence of relict hominids must use universal primers over long sequences and must properly query their sequences against a reputable sequence database.

2.2 Yeti (or Abominable Snowman)

An alleged animal similar to Sasquatch, and sometimes proposed as a relative to Sasquatch in the same supposed genus *Gigantopithecus* [76], is the Yeti of the Himalayas, or "Abominable Snowman'. The Yeti is generally described by witnesses as hairy and dark-skinned with a hominoid face, though accounts differ as to whether alleged Yeti are bipedal or quadruped, and short or tall [60, 39]. For this reason, some have speculated that the Yeti represents two distinct unknown animals [36]. Emanuel Vlcek of the Czechoslovak Academy of Sciences documented Yeti-like animals (variously named "bitchun", 'Kumchin gorugosu", "peeyi", and "zerleg khoon") in Tibetan bestiaries from the eighteenth and nineteenth centuries [64], suggesting a long history between this alleged animal and the indigenous people of Tibet.

In 1951, the British Mount Everest reconnaissance expedition, led by mountaineer Eric Shipton, photographed unidentified animal tracks on the

Menlung Glacier [56], generating much attention. Zoologist Wladimir Tschernezky attempted to reconstruct the foot of the animal responsible for the Shipton tracks, demonstrating great size and breadth, with a thick hallux separated from other toes, and general resemblance to the gorilla, "most probably of a similar type to the fossil *Gigantopithecus*" [89].

FIGURE 2.2
Outline of Menlung Glacier "Snowman" footprint (left) and reconstruction of the "foot" after Tschernezky [89]. Summer Matthews drawing. Redrawn with permission from Springer Nature.

Later in 1972, chief scientist of the Arun Valley Wildlife Expedition Edward Cronin [14] and mammalogist Jeffery McNeely photographed and cast similar prints around Kongmaa Mountain. Reconstructions of the latter prints by Cronin resemble those of Tschernezky. However, conservationist Daniel Taylor [85] suggests each singular "footprint" photographed by Shipton is actually a "double" footprint, made by the front and rear paws of the Asian black bear *Ursus thibetanus*; Taylor noted that claw marks appear in the center of each "single" print.

Participants of the First Swiss Expedition to Mount Everest in 1952, as well as the subsequent 1953 British Mount Everest expedition (which marked the first recorded successful attempt to ascend Everest), and the London Daily Mail Expedition of 1954, all similarly reported seeing strange animal prints in the snow of the Everest region [97, 54, 56].

Numerous scientific or amateur expeditions have been fielded in search for Yeti and evidence thereof. In 1957, the finger of an alleged Yeti hand at the

Pangboche monastery in Nepal was traded by the local monks for the low price of a single monetary donation and a human finger to replace it [27]. The Yeti finger itself was subsequently identified as that of a human. In 2011, a DNA analysis of the finger by geneticist and molecular ecologist Rob Ogden of the Royal Zoological Society of Scotland confirmed this observation [6].

In 1959, a Himalayan mountaineering expedition organized by the All-China Federation of Sports and consisting of scientists from Peking University and the Chinese Academy of Sciences, reportedly obtained a 16 cm long hair inconsistent in structure with hairs of the orangutan, brown bear, and yak [30].

From 1960 to 1961, Edmund Hillary led the Silver Hut expedition to the monastery at Pangboche in Khumjung, Nepal, with zoologist Lawrence Swan and mammalogist Marlin Perkins [63]. A "Yeti Hunt" of the Rowaling Valley ensued, and the expedition members obtained an alleged Yeti scalp from the locals in exchange for a donation to the local monastery and school (no replacement scalp required). While mammalogist Biswamoy Biswas of the zoological Survey of India determined that the scalp was not an artifact [82], Perkins and others determined that the scalp was fashioned from the skin of the Himalayan serow *Capricornis sumatraensis thar* [56, 4]. This conclusion was reportedly met with disbelief among the local population [60]. One monk allegedly reacted by saying "[we]e don't believe in giraffes and lions in Nepal because there aren't any there. Likewise, you don't believe in Yetis because you have none in your country" [87]. The original "scalp" was returned to the Khumjung monastery, and a duplicate (also made from serow hide) is kept at The Explorers Club in New York City. It has also been argued that both the Yeti "hand" and "scalp" were ersatz remains not intended to mislead [2], similar to the "Centaur Excavations at Volos" exhibit at the University of Tennessee, created by zoologist William Willers [55]. This did not stop Heuvelmans from assigning to Yeti the binomen *Dinanthropoides nivalis* ('two snow apes'), a name also advocated by zoologist Francois de Sarre, which remains officially unrecognized [37, 19].

The first reported photograph of the Yeti was taken by mountaineer Anthony Wooldridge in the Garhwal Himalayas in 1986 [94]. A large, dark silhouette was seen against the backdrop of snow, apparently standing motionless behind a shrub for approximately one hour. The photograph was digitally enhanced by the United Kingdom Atomic Energy Authority's Harwell Laboratory to improve the image contrast, and an artist's impression was made. Zoologist Charles Reed and fieldworker Daniel Taylor-Ide suggested the subject photographed was a rock protruding through the snow [66, 86]. On a subsequent trip to the same area the next year, Wooldrige confirmed with photogrammetric analysis that the subject of the 1986 photograph was indeed a rock [95].

Biologist Arkady Tishkov of the Russian Academy of Sciences purportedly spotted a Yeti and photographed its supposed faeces during the Soviet-Chinese

Glaciological Expedition to Tibet in 1991 [88]. The faeces appeared to contain plant tissues but were not otherwise analyzed. Photographs of the Yeti were inconclusive owing to emulsion grain blur.

In 2008, purported Yeti hairs from Meghalaya in north-east India were analysed by primatologist Anna Nekaris and tropical field biologist Ian Redmond [50]. Microscopic examination ruled out the Asian black bear, wild boar, and macaque monkeys as the likely source of the samples. Subsequent DNA testing on these hairs in a US-based laboratory identified the Himalayan goral *Naemorhedus goral* as the source [51]. Despite not representing Yeti hairs, this find was interesting because the apparent location from which the hairs were collected was much further south than the known distribution map of the goral.

In 2014, a systematic genetic survey used RNA sequencing to analyse alleged Sasquatch and Yeti hair samples solicited from museums and private collections. Of 57 samples collected, one was of plant material, another of fibre glass, seven failed to yield sequences, and the remaining samples that underwent genetic analysis matched to 12S rRNA sequences of known mammals in GenBank [84]. Curiously, the original article reports that two samples collected in the Himalayas region matched to a Pleistocene subfossil of the polar bear *Ursus maritimus*, but did not to match to modern examples of this species. The authors of the genetic survey article suggested that these samples may represent some unrecognised bear species, hybrids between *U. maritimus* and *U. arctos* (brown bear), or colour variants of either species. This result was disputed by other archaeologists and palaeontologists since the closest GenBank match was actually to a modern *U. maritimus* specimen, and degradation-induced errors may have been introduced in sequencing because the samples were old and poorly kept [23, 31]. In which case, the Himalayan brown bear *U. a. isabellinus* cannot be ruled out as the source of the sample. The original authors subsequently acknowledged the closest-match error, but defended the quality of the samples, and called for fresh tissue collection from a living specimen to clarify the still-imperfect matching [58]. Paleontologist and Senior Editor of *Nature* Henry Gee has remarked that other paleontological discovories may increase the likelihood that "mythical, human-like creatures such as Yetis are founded on grains of truth" [28].

A later study of 24 field-collected and museum samples of hair, bone, skin and faeces from the Himalayan region all matched to local brown and black bears [49]. After twice witnessing a Yeti and initially becoming convinced of its existence, mountaineer Reinhold Messner [59] subsequently dedicated much time to studying the Yeti phenomenon, and decided that the Yeti "is a collective term for all the monsters of the Himalayas, real or imagined... that corresponded to the brown bear."

Indeed, it seems that wherever there are bears, mystery hominids are said to exist. The author has demonstrated a significant association between Sasquatch sightings and black bear populations across US states and Canadian provinces in a generalized linear model adjusting for forest area and

human population [25]; every 1,000 bear increase in the bear population is associated with a 4% increase in Bigfoot sightings. Orang-Pendek, the ape-man of Sumatra, has similarly been compared to the Malayan sun bear *Helarctos malayanus malayanus*, an animal that habitually walks on its hind legs and whose hind paw prints appear identical to purported Orang-Pendek prints [36].

FIGURE 2.3
Choropleth maps of number of Bigfoot sighting reports (upper left; data from [3]), number of black bears (upper right; data from [78]), number of humans (lower left; data from [90, 79]), and forest area (lower right; data from [65, 92]) across US states and Canadian provinces by Floe Foxon [25]. States/provinces with fewer bears and less forest area may still have many Bigfoot sightings if they have many humans to make such observations.

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3

Big Cats

Felids (cats) have captured human attention for millennia; they were admired in the Ancient Near East and featured prominently in Egyptian and Islamic religion and culture [29, 8]. Consequently, the cat has entered global folklore.

Like the coelacanth, the "king cheetah" is an example of an animal that was at one time unknown to conventional zoological science but was well known to indigenous people. Circa 1900, Zimbabweans recognized the king cheetah, which they called nsuifisi, as distinct in appearance from other felids such as cheetah, lions, and leopards [4]. This distinction was characterized by an extremely rare coat with black, blotched stripes running from spine to rump.

Early descriptions identified the animal first, based on photographs, as a hybrid between leopard and cheetah [12], and then as a new species, *Acinonyx rex* ('cheetah king'), with a museum skin as the holotype [34]. Approximately six decades later, nine king cheetah were born in captivity to ordinary wild-type cheetah *A. jubatus*. The rare coat unique to king cheetah was revealed as a genetic color variant, the result of recessive alleles [46]. This is not unlike how mutations in the DKK4 gene lead to the variety of color patterns observed in the domestic cat *Felis catus* [27]. In fact, this mechanism was proposed by Robinson a decade before observation in 1986 [35].

Other big cats of unusual pigmentation have also been reported. A blue tiger was purportedly sighted in 1910 in Fujian, China [11]. Crpytozoologist Karl Shuker has suggested that the blue pelage of the "maltese tiger" is a recessive trait [37], not entirely unlike the leucistic white tiger of India; a mainland Asian tiger *Panthera tigris tigris* that has partially lost its pigmentation through a single amino acid change [50].

3.1 Eastern Cougar (and Onza)

Cougars (also known as pumas, panthers, and mountain lions) are still found in the western hemisphere. The eastern cougar *Puma concolor couguar* was a subspecies of cougar endemic to the eastern US until settlers from Europe transformed the land and its fauna. Deforestation and deer hunting (deer comprised a significant portion of the cougar's diet) pushed cougar populations

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into decline [33]. By 1942, the species was considered largely extirpated from the east [1].

FIGURE 3.1
Photo of a cougar at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania by Floe Foxon.

Some attest that the eastern cougar survives today. The purported existence of relic eastern cougar populations has been characterized as "a Bigfoot-like mystery" [9]. Lee investigated the possible existence of eastern cougars in North Carolina through the 1980s [28]. Evidence was not suggestive of existing cougars in the state. Interestingly, two reports were determined to be lion *Panthera leo* subspecies, which are not native to the United States.

In response to legal challenges over the status of the eastern cougar, the US Fish and Wildlife service and US Forest Service sponsored a six-year study to document dozens of reported kills, tracks, screams, and covered deer carcasses between 1900 and 1985 (for which bobcats may also be responsible) [15]. This research was unable to confirm the existence of a self-sustaining cougar population along the East Coast north of Florida. Notably, no wild cougar specimens were recovered in the east after the 1930s.

In 1990, an eastern cougar was reportedly filmed in New Brunswick, Canada [41]. Analysis of the filming location with survey stakes, a re-enactment, and work by the Royal Canadian Mounted Police crime laboratory

in Ottawa led wildlife biologist Gary Moore and ecologist Jay Tischendorf to conclude that the footage was genuine and depicted a young cougar in the far north east. A search of the New Brunswick area was subsequently undertaken in 1992 by the Friends of the Eastern Panther field team, though evidence indicated only the presence of coyotes and domestic dogs, with no evidence of pumas [42]. The Fish and Wildlife Service ultimately declared the eastern cougar extinct in 2018 [45]. The survival of the eastern cougar appears doubtful, but colonization of the eastern US by western cougars, without even an organized reintroduction, is not impossible. Indeed, Rossi et al. note that "[b]ig cats can "reappear" unexpectedly even many years after their official disappearance" [36].

FIGURE 3.2
The bobcat *Lynx rufus* may be responsible for some reports of eastern cougars in the eastern US and Canada. Photo of a bobcat at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania by Floe Foxon.

Another mystery big cat called the onza, which has been linked to the cuitlamiztli of Aztec folklore, has been reported across Mexico, especially Sinaloa [24]. The onza is described as cougar-like but with a more slender build [10]. This led mammalogist Helmut Hemmer to speculate that the onza may represent a surviving Pleistocene American cheetah, *Miracinonyx trumani* [23].

In the 1950s, a supposed onza skull sans mandible dubbed the "Los Frailes skull" was found in Sinaloa [20]. Dental analysis of the skull was inconclusive.

In 1985, two more skulls with peculiar morphology were found (the "Vega skull" and the "Carpenter skull', one in the collection of the Academy of Natural Sciences in Philadelphia) [20]. These were not considered consistent with the Pleistocene American cheetah hypothesis. A complete specimen (the "Shirk onza') was obtained and photographed already in 1938, and while the skull of this specimen was examined in the 1950s, it was reportedly lost thereafter.

In 1986, a complete 27 kilogram female "onza" was obtained [21]. Samples of this specimen were taken by zoologist Troy Best at the Regional Diagnostic Laboratory of Animal Pathology in Sinaloa, which were sent to the United States on scientific loan for analysis. Protein analyses and mtDNA sequencing were performed at the US National Cancer Institute, and results were compared to nine other cat species [16]. The onza specimen shared 100% of mtDNA restriction fragments with the cougar *Puma concolor*, and the onza's ND5 nucleotide sequence was 100% identical to the cougar's. Protein analyses also ruled out the onza being a hybrid, e.g., cougar × jaguar. As for its thin and long-legged appearance, the authors suggested that the poor animal was simply emaciated at the time of death. Not all locals are convinced that this specimen was a true onza [2]. Greenwell called the specimen a "regional peculiarity" [22].

South America has its own mystery cat speculation. In Peru, there are reports of a jaguar-like cat with tiger-like stripes that is said on occasion to track hunters in the upper Abujao and lower Palcazu river regions [25]. Skull specimens putatively from one such "striped tiger", as well as a cinnamon-brown "anomalous jaguar", both sans skin, were obtained in 1992 and 1993 by ornithologist Pedro Hocking of the Museum of Natural History, Lima [26]. Though preparation of these skulls confounded DNA extraction, their morphometric properties were compared to approximately 300 specimens from known species in a linear discriminant analysis [31]. Both skulls were identified as the jaguar *Panthera onca* with high probability. It cannot be determined whether these two animals did or did not possess unusual pelages.

3.2 British "Beasts" (of Exmoor, Bodmin Moor ...)

Even more intriguing are reports of big cats in places they have never been known to exist naturally. "Alien" big cats are felids putatively found outside of their ordinary ecological constraints. The king cheetah is to alien big cats what the gorilla is to Sasquatch; an example of how ethnoknown animals can go surprisingly unknown to science, and are used to support the possible existence of other ethnoknown animals.

In the UK, the British Big Cats Society collected over 2,000 big cat sightings between April 2004 and July 2005 alone [5]. Sightings increased during the

1970s and 80s, coinciding with the passage of the Dangerous Wild Animals Act 1976; a law which regulated ownership of exotic and wild animals by private citizens, including various species of genera *Felis* (except *Felis Catus*), *Leopardus*, *Catopuma*, and hybrids thereof [39]. One of many possible explanations for British big cat sightings is the release of privately owned non-domesticated cats following this legislature.

The geographic and temporal distributions of British big cat sightings have been studied [13]. In the 1960s, reports were concentrated only in and around London. In the 1970s and 80s, reports expanded to the Southwest and Scotland. In the 1990s, reports expanded again to the East of England. This has been interpreted as an increase in the number (through breeding) and range of alien big cats in the country. A possible alternative explanation is that the publication of media articles concerning big cats has generated more and more "sightings" as people "see" what they expect to see.

The "Beast of Exmoor" was a mystery big cat of the Somerset and Devon moorlands in England, purportedly responsible for livestock deaths in the 1980s. The result was "Operation Beastie": a hunt executed by local police and the Royal Navy Corps of Royal Marines [18]. One marine reportedly claimed to have sighted a large cat-like animal, but no physical evidence was obtained, and the hunt was called off due to an influx of amateurs seeking bounty for the beast from a newspaper.

The "Beast of Bodmin Moor" is another such alleged animal of Cornwall, England, similarly attributed to livestock deaths in the 1990s [30]. Royal Auxiliary Air Force volunteers undertook a search dubbed "Operation Pussycat" but "reported seeing nothing more threatening than ponies" [47]. The Zoological Society of London also investigated. During this time, a large felid skull was recovered in Cornwall and provided to zoologist Daphne Hills and entomologist Judith Marshall of the Natural History Museum (London) for analysis; the skull belonged to the leopard *Panthera pardus*, but contained a tropical cockroach ootheca (egg case) and featured preparatory cut marks suggesting the skull did not originate in the UK [32]. The same year, a six-month scientific investigation commissioned by the former Ministry of Agriculture, Fisheries, and Food, found no verifiable evidence for the presence of big cats in the Bodmin Moor area [3]. This investigation involved analyzing supposed photographic evidence of cougars and/or leopards in the moor by visiting the locations of these photographs with ranging poles for scale. The sizes and proportions of the animals pictured were consistent with domestic cats. Of three footprint casts analyzed, two were from domestic cats and the third from a dog. Livestock carcasses did not show traumatic injuries consistent with big cats; some were more consistent with large dogs.

Alien big cat sightings are not constrained to England; over 1,000 sightings were claimed in Scotland between 1926 and 2007 [40]. The "Beast of Buchan" is another such creature, assertedly of Aberdeenshire, Scotland. Unlike England, the domestic cat is not the only known cat population in Scotland; the Scottish wildcat *Felis silvestris silvestris* is a native European wildcat

population found in the highlands [14]. Dismissed sightings of unidentified black, fox-size cats in the North of Scotland were vindicated in the 1980s, when multiple specimens were obtained. Originally considered by some to be a distinct taxon, these "Kellas" cats (named after the village in Moray, Scotland) were eventually identified as Scottish wild cat × domestic cat hybrids [38]. Morphological differences between various Kellas cat specimens are attributed to generational differences, with some specimens representing the first filial generation of offspring (F_1), and others representing subsequent generations with more complex introgressive hybridization. Kellas cats have been found in the Aberdeenshire area; a specimen is held at the University of Aberdeen Zoology Museum [43].

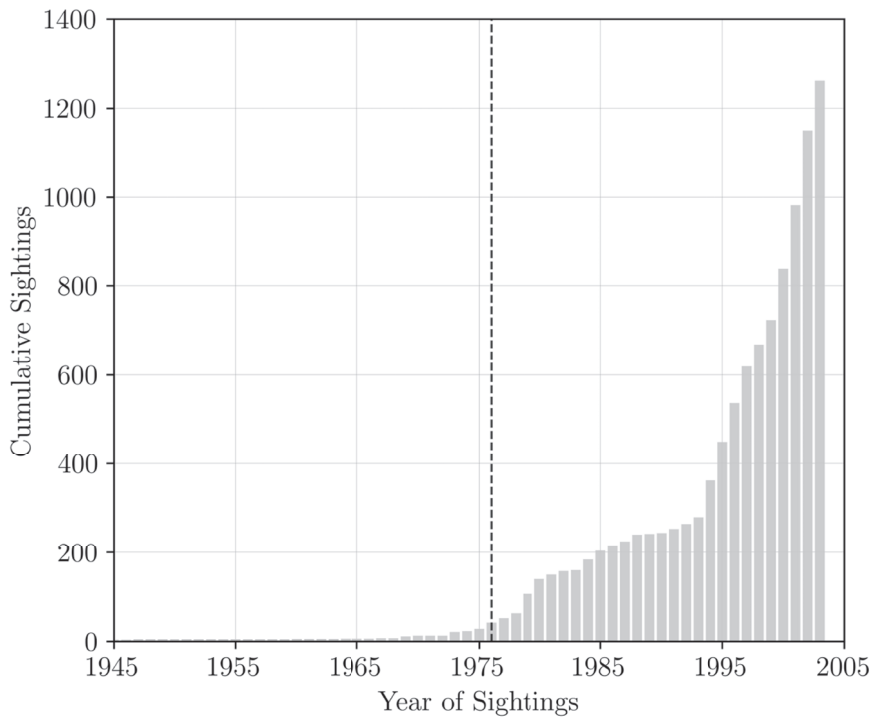

FIGURE 3.3
Cumulative sightings of non-native cats in Scotland number over 1,000. The vertical dashed line indicates the year of the Dangerous Wild Animals Act 1976. Data from [40]. Figure by Floe Foxon.

Various photographs and videos of British "big cats" have been published. In one case, a photograph of an alleged "lion" in Essex, described as "poor quality" by the Zoological Director of Colchester Zoo [6], was subsequently identified by its owner as a Maine Coon named "Teddy Bear" [7].

In addition to photographs, alien big cat samples have been analyzed for DNA and other evidence. In 1996, hair purportedly belonging to the "Beast of Kingsteignton" were analyzed (e.g., with electron microscopy) by principal curator of vertebrate biology Andrew Kitchener of the National Museum of Scotland and cryptozoologist Lars Thomas [48]. These hairs likely belonged to cows, horses, and dogs.

In 2003, hair samples reportedly collected from the "Lincolnshire Leopard" underwent forensic analysis by DNA testing companies DNA Bioscience and RGJL. They concluded that the sample was "not that of a domestic cat," but was instead consistent with the genus *Panthera* (including lions, tigers, leopards, and jaguars) [17].

In 2011, Durham University similarly concluded that separate hair samples collected in England by Thomas were probably leopard in origin [49]. Notably however, because these hairs were not collected from live specimens or cat carcasses, it is not clear that they originated from live, wild animals in the UK.

In 2012, the National Trust commissioned the University of Warwick to undertake PCR testing on 45 deer carcass samples in Woodchester [44]. Besides deer, the predominant DNA identified was that of the red fox *Vulpes vulpes*, with no felid DNA detected.

Thus, it seems plausible that some isolated "big cat" incidents in the UK are attributable to real big cats, but these do not necessarily constitute self-sustaining populations. Rather, they may be releases or escapees from circuses, zoos, or private ownership [19]. Private ownership of big cats is remarkably common in the UK, providing parsimony to this argument.

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4

Birds

There are relatively few unrecognized flying animals, at least compared to those which are not reported to fly. This comes as little surprise; according to the 2022 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation by the US Fish and Wildlife Service, over 96 million people in the United States observed birds in 2022 [51], and many other countries have similarly high prevalence of bird watching. Thus, it seems relatively unlikely that new flying species remain undiscovered in many countries. Still, much attention has been focused on a handful of maybe-animals, chiefly among them a picid.

4.1 Ivory-Billed Woodpecker (or Log God)

The ivory-billed woodpecker, *Campephilus principalis*, is or was the largest North American woodpecker, with glossy black plumage and ivory-white bill [50]. Once semi-abundant and ranging from the east of Texas to the Carolinas and Cuba [2], its population was decimated in the 19$^{\text{th}}$ and 20$^{\text{th}}$ centuries by human activities in the specimen collection and logging industries [38], the latter depriving the ivory-billed woodpecker of the insects and larvae from rotten wood crucial to its diet [5].

Ornithologist James Tanner undertook significant scientific research on the American ivory-billed woodpecker subspecies, *C. p. principalis*, and in the late 1930s, provided a population estimate of fewer than 30 individuals in the south-east US, though this estimate has been criticised by National Aviary of Pittsburgh research associate Mark Michaels as having been based on incomplete data [40]. A small population of ivory-billed woodpeckers persisted in the 1940s on the Singer Tract in Louisiana, before their habitat was mercilessly destroyed by German war prisoners employed by an American lumber corporation [20].

Amid controversy, reports of extant American ivory-billed woodpeckers have persisted since the 1940s, with dozens of eyewitness accounts in the 21$^{\text{st}}$ century [26]. Researchers at the Cornell Laboratory of Ornithology reported in *Science* their alleged rediscovery of the ivory-billed woodpecker in the Big Woods of Arkansas [17]. These authors reported sighting the bird from

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2004–2005 and presented a video (the "Luneau" video) of a large woodpecker, asserting that the size, wing pattern, and dorsum plumage were that of the ivory-billed woodpecker.

While some, including ecologist David Wilcove [52], have praised the "Luneau" video, others remain unconvinced. In a re-analysis of the same video, ornithologist David Sibley et al. suggested that the film subject is a pileated woodpecker, *Dryocopus pileatus*, noting among other features "a black band that curves around the wingtip and back along the wing's trailing edge" [44], a feature characteristic of pileated woodpeckers. This was rebutted by Fitzpatrick et al. as "misrepresentations of a pileated's underwing pattern, interpretation of video artifacts as plumage pattern, and inaccurate models of takeoff and flight behavior" [18], though Sibley et al. disagreed with this response as having only "disputed secondary parts of our analysis" [45]. The Arkansas data have also been seriously criticized by ornithologist Jerome Jackson as "too short and hav[ing] too many problems to inspire confidence" [29, 30], noting that the environment of Arkansas is unsuited to the ivory-billed woodpecker, and that other surveillance efforts in this state have not produced evidence of the woodpecker there.

From 2005-2006, researchers at Auburn University and the University of Windsor reported 14 visual sightings of birds purportedly matching the diagnostic shape of the ivory-billed woodpecker and audio recordings of putative knocks and calls within ivory-billed woodpecker frequency range, all in the swamp forest along the Choctawhatchee River, Florida [28].

To assist in the search, recent years have seen the implementation of camera-equipped remotely operated aerial vehicles (drones) [13], not unlike how advancements in underwater photography were exploited to search for hidden animals in Loch Ness (see Chapter 6). However, a recent simulation modelling study estimated an abysmally low probability of persistence in 2011 of $< 6.4 \times 10^{-5}$ [22]. Indeed, in 2010, Ronald Rohrbaugh, Director of Conservation Science and Forest Programs at Audubon Pennsylvania, and co-author of the original Luneau video study, stated that "[w]e don't believe a recoverable population of ivory-billed woodpeckers exists" [14].

Project Principalis is a collaboration between the National Aviary and researchers, community scientists, and naturalists involved in the search for surviving ivory-billed woodpeckers [42], though to date no living or recently-deceased specimen has been obtained. In 1985, the US Fish and Wildlife Service initiated a status review of the ivory-billed woodpecker, deciding that a last-ditch effort should be undertaken before declaring the bird extinct [24]. In 2021, the Service announced their proposal to finally declare its extinction, with opportunity for public comment [15]. A response to the proposal by Project Principalis collated multiple lines of evidence to indicate the survival of the ivory-billed woodpecker in Louisiana [32], including trail camera photographs and drone videos from 2021. Again, not all are convinced: ornithology

FIGURE 4.1
Pileated woodpeckers may be responsible for purported sightings of ivory-billed woodpeckers. Photo of pileated woodpeckers (left: male; right: female) at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania by Floe Foxon.

collection manager Mark Robbins said of one video "[i]t is quite clear the bird that they are calling an Ivory-billed is a Wood Duck", while Brett Hartl of the Center for Biological Diversity commented "To be blunt, there are better and more reliable photographs of Sasquatch" [37]. A decision on the proposed rule was due in 2023 [16], and in October of that year, the agency announced that it was delaying its decision to review all available evidence [23].

The American ivory-billed woodpecker's Cuban cousin did not fare much better. The Cuban subspecies, *C. p. bairdii*, persisted slightly beyond the American counterpart with sightings made in the 1950s and 60s [12], but was considered extinct by some in the 1970s. A rediscovery occurred when ornithologists observed the Cuban ivory-billed woodpecker in the Ojito de Agua forest in 1986 and 1987 [24], which were the last confirmed Cuban sightings. The bird is now almost certainly extinct in Cuba: extensive surveys were undertaken in 1991 and 1993, but revealed only ambiguous *Pinus cubensi* bark scaling, likely caused by atmospheric phenomena [31].

4.2 Thunderbird

While the ivory-billed woodpecker is officially recognized as at least having once existed, the existence of other supposed flying species is even more speculative. The "thunderbird" is a folk animal that features prominently in the traditions of some indigenous American peoples, as documented by folklorist Adrienne Mayor [35]. In the Sioux creation myth, the thunderbirds were supernatural beings who blasted water monsters into stone with lightning. This tradition has been interpreted by some as representing a real animal; an alleged cathartid-like raptor, with a supposed wingspan of over four meters, which would make it larger than all known extant condors and eagles of the Americas [27]. Recent supposed sightings of thunderbirds have been reported throughout the US and Canada [25].

The thunderbird has speculatively been identified as a member of the Pleistocene avifauna [11], namely a teratornithid such as *Teratornis merriami* [41], which had a wingspan upwards of four meters, and which may have flown in a similar manner to condors [9]. Teratornithid specimens have been dated to 12,000 years BP [8], which certainly makes them contemporaneous with people in the Americas [4, 46]. It is possible then, that the thunderbirds may represent a cultural memory of now-extinct forms, then-contemporary, passed down through oral tradition similar to South American traditions of ground sloth-like animals (see Chapter 5). Alternatively, Mayor suggests that fossil *Pteranodon* remains, exposed by lightning storms in the badlands of South Dakota, and discovered by indigenous peoples alongside fossils of Cretaceous marine reptiles, may have inspired such thunderbird traditions as those of the Sioux [35].

Of course, these traditions may also have purely fictional bases. Native American skeptic Noah Nez has described the thunderbird tradition as distinct from any real animal, being instead stories intended to relate to and explore nature [43]. Nez notes that "it may even be considered disrespectful to suggest that a person could see, or has seen, a Thunderbird" [43].

More recent supposed sightings from the 1940s and 70s of extraordinarily large birds in Illinois and Pennsylvania (e.g., see [11]) may simply be cases of mistaken identity [48]. The estimation of size of objects observed on land is aided by comparison to objects of known size. For example, an object may be compared to the size of a tree or house against which it was seen. Estimation of object size in water is more challenging because waves are very loosely "fractal", in the sense that they exhibit similar repeating patterns on different scales (i.e., small and large waves of water can look similar. This trick is sometimes used by the film industry to create the illusion of giant waves from small ones). Size estimation is perhaps even more problematic in the sky, because there are no trees, houses, waves, or shorelines to serve as references. The size of an object is a function of the angle subtended by it and the distance

between the object and the lens of the observer. Honest misjudgement of distance (common even in roadway settings with many reference objects [49]) will therefore result in misjudgement of size. Perhaps some "thunderbird" sightings were of much smaller birds already known to science.

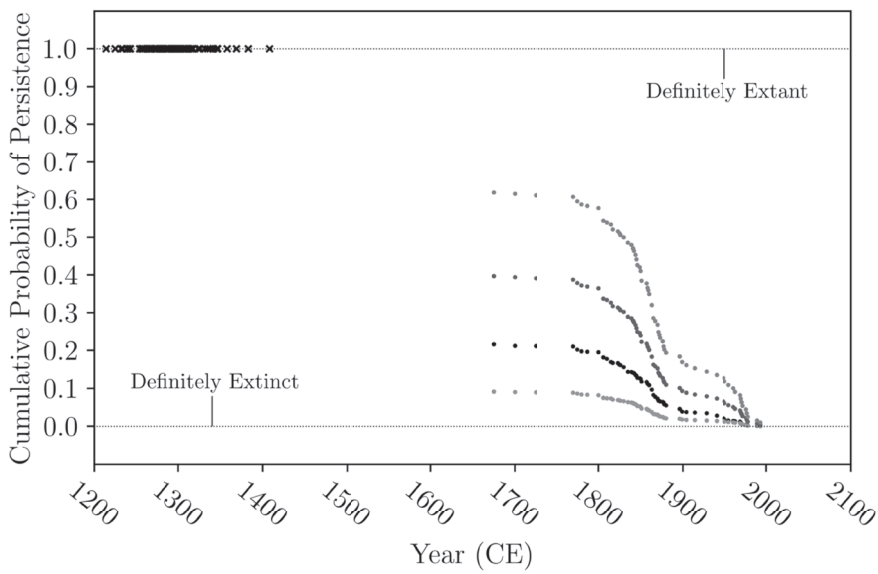

FIGURE 4.2
While North America has the thunderbird, New Zealand has the Moa; large flightless birds that once flourished on the islands but were hunted to extinction circa 1450 CE. Despite lack of physical evidence, Moa sightings have persisted in New Zealand from the arrival of Europeans circa 1770 CE to the present. The author has modelled the extinction dynamics of the Moa from 97 alleged Moa sightings [19]. The models estimated only low probability of Moa persistence after 1675 CE (represented by dots) across a range of optimistic (higher probability) and pessimistic (lower probability) model assumptions. Crosses represent radiocarbon-dated Moa remains from archaeological sites. Model adapted from [6] with data from [47]. Figure by Floe Foxon [19].

Prehistoric survivors, speculative range extension, and escape from captivity of such large extant birds as the Andean condor *Vultur gryphus* may not be necessary to account for sightings of apparently gigantic birds in the skies over North America; local eagles and vultures whose size has been miscalculated may suffice. Zoologist Aaron Bauer points out that, in a densely populated state such as Pennsylvania with a large audobon society, there are fewer records of massive diurnal birds than would be expected if a cryptid population truly exists [3]. Ornithologist Angelo Capparella notes the necessity

of an extensive food source necessary to support such large forms [10], which simply does not exist in many places where sightings have been reported.

4.3 Griffin

Although the thunderbird tradition may have no exact basis in real fauna, there is another bird legend attributable to forms that once existed. According to Mayor [34] and Mayor and Heaney [36], circa 675 BC, ancient Greek poet Aristeas travelled to Scythia, where Issedonian nomads informed him of the existence of lion-sized predators with beaks. The griffin motif in Greece was popularized thereafter, but was neither sensationalized nor supernaturalized in ancient texts, and played no role in myths of gods and monsters. Instead it was depicted naturalistically as an extant quadruped that nested on the ground, moved in packs, fed on horses and men, and hoarded gold. In the years that followed, wings and long necks were added to griffin depictions, as the animal became mythologized.

To prospect for placer gold in the sands of the Tien Shan and Altai mountain basins, Issedonian nomads traversed the fossiliferous Gobi desert, where the chalk-white fossils of the primitive ceratopsian *Protoceratops andrewsi*, exposed by erosion processes, were easily noticeable against the bright red sediment of the Djadochta sandstone formation. *P. andrewsi* was a lion-sized, quadruped ornithischian dinosaur of the Cretaceous period, which, like a bird, nested, laid clutches of eggs, and featured a beak and bird-like pelvic structure. Based on observations by geologist Georg Erman, Mayor [33] hypothesised that the griffin was really an ancient reconstruction of *P. andrewsi*, or in the words of biologist John Acorn, a "2,700-year-old interpretation of an 80-million-year-old fossil" [1]. While some have criticized Mayor's data and inferences [53, 7, 21], Mayor's hypothesis still seems plausible.

FIGURE 4.3
The bird-like pelvic structure and beak of these ceratopsian fossils may have inspired the motif of the griffin in ancient culture. Photo of *Protoceratops andrewsi* at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania by Floe Foxon.

As detailed by Mayor [34, 35] and earth scientist Ken McNamara [39], the griffin hypothesis parallels "bird claws" described by gold miners in the northern Urals in the 1800s (really Pleistocene rhinoceros and mammoth remains); "dragon bones" in China (Pliocene horse and deer) and in northern India (Miocene giraffids); Thunder Beasts of the Sioux peoples' tradition (possibly inspired by dinosaur fossils); and "Saints' relics" in mediaeval Europe (various prehistoric animals).

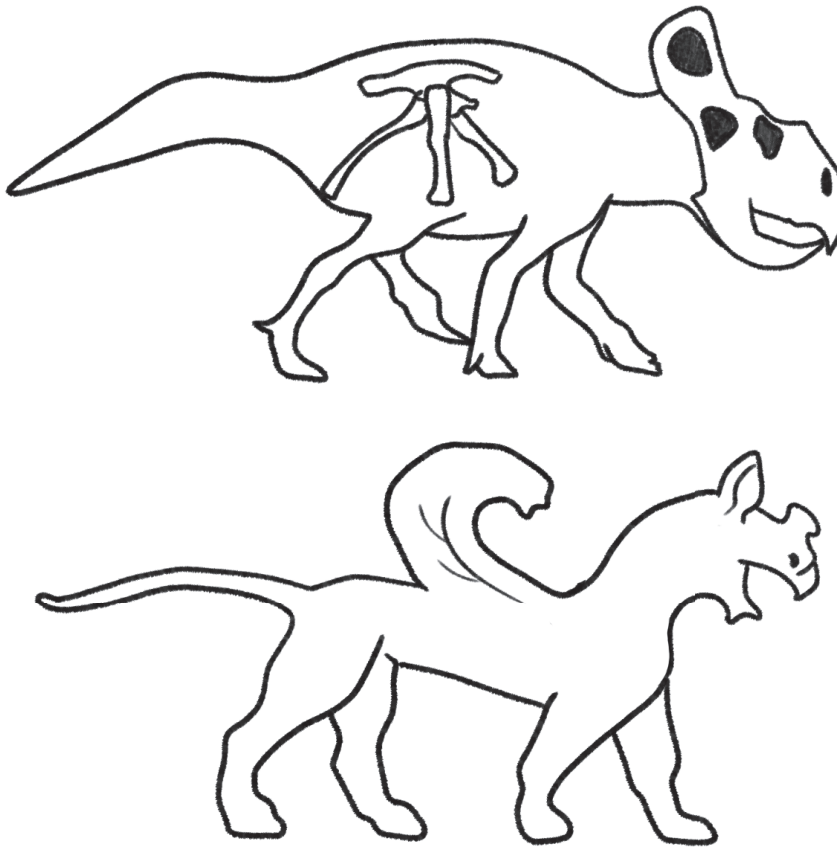

FIGURE 4.4
Top: *Protoceratops* silhouette with bird-like beak and pelvic structure, after Figure 4.3 above. Bottom: The griffin, a possible ancient reconstruction of *Protoceratops* fossils. Summer Matthews drawing.

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5

Other Terrestrial Animals

Speculation in mammalogy has its origin in ancient historical times. It is a common misconception that the Greco-Romans and other ancients engaged little in paleozoology. On the contrary, fossils were collected, described, measured, illustrated, and displayed in temples and museums in antiquity [26]. The Greco-Romans lacked a theory of ancient life, and instead reconstructed fossil remains (often composite) as giant Hellenic heroes or deformed ogres from a distant heroic age, with crude taxonomy based on mythical geography [26].

5.1 Cyclops (or Giants)

Dozens of examples of ancient paleozoology have been collected by folklorist Adrienne Mayor. In 1914, evolutionary biologist Othenio Abel suggested that the ancient Greeks reconstructed Pleistocene elephant skulls, found in Mediterranean coastal caves, as Homeric cave-dwelling cyclops, with the front-facing nasal orifice interpreted as the orbit for a single large eye [26]. Remains of the steppe mammoth *Mammuthus trogontherii*, discovered by ancient Syrians in the Orontes riverbed; the woolly rhinoceros *Coelodonta antiquitatis*, discovered by Messenians; and Miocene mammals exposed by storms near the river Hyllos in Turkey, were all similarly reconstructed and anthropomorphised as giants or burrowing monsters [26].

Mayor suggests that mammutid remains exposed by plate tectonics, and discovered by ancient mineral collectors on the Greek island of Samos, may have inspired the mythical battle of Dionysus and his Indian war elephants against the Amazonians [26]. These were alternatively reconstructed as "Neades"; giant primeval monsters, thought by the ancients to have buried themselves in earthquakes caused by their own vocalisations. Less monstrously, some ancients interpreted fossil proboscidean tusks as having been intentionally buried by extant elephant forms [26].

As detailed below, paleozoology with folkloric characteristics is not unique to the Mediterranean. In the cases above however, descriptions of mythical

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animals were accompanied by written descriptions of the observations (of fossils) that inspired them. In other cases, descriptions of animals are not accompanied by specimens, and the folklore itself may be analyzed to obtain a possible identity, if the animal ever existed.

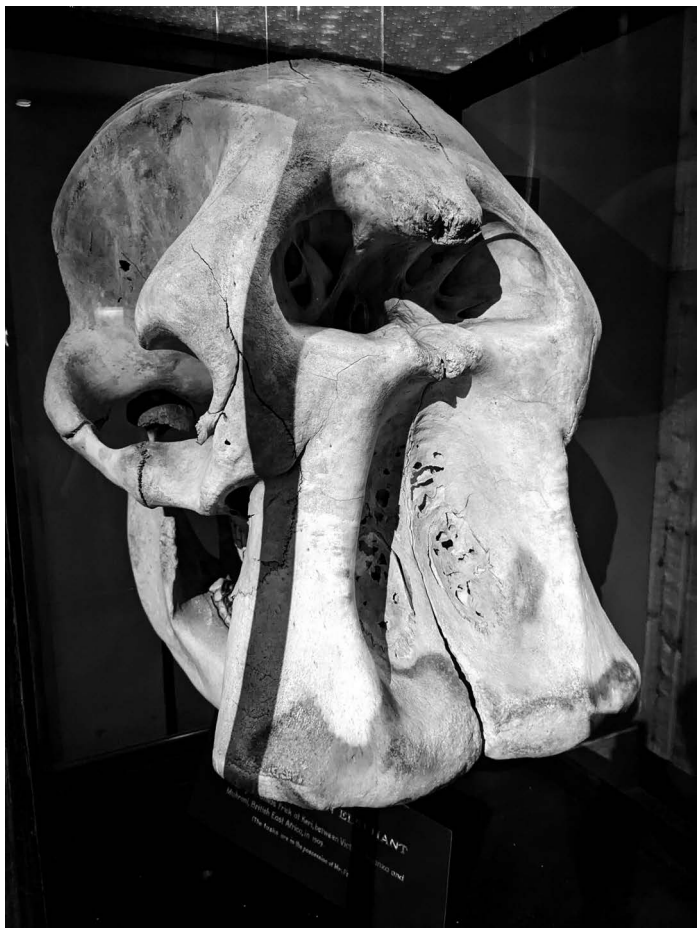

FIGURE 5.1
Elephantid skulls contain a large, forward-facing orifice where two eye sockets would be on a human skull. This may have inspired the cyclops myth of the ancients. Photo of African elephant *Loxodonta sp.* skull at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania by Floe Foxon.

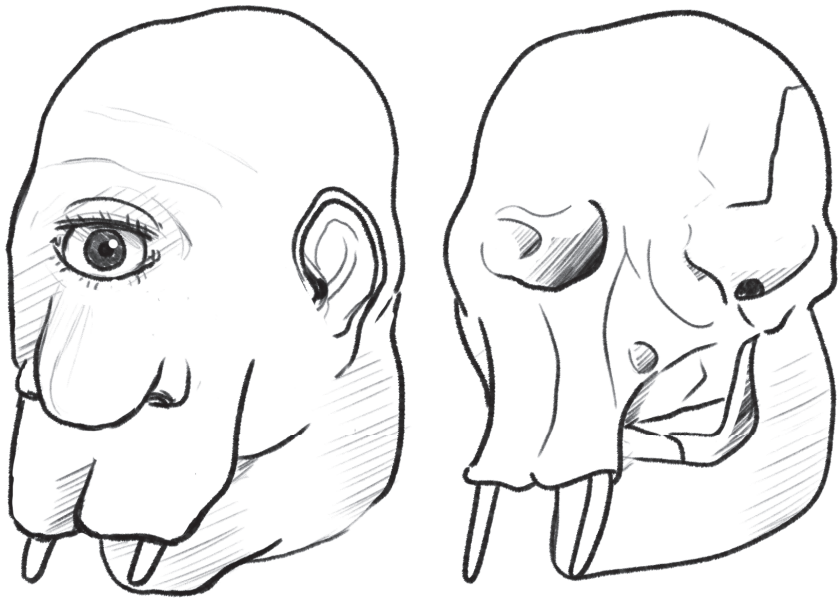

FIGURE 5.2
Reconstruction of an elephantid skull (after Figure 5.1 above) as a one-eyed giant. Summer Matthews drawing.

5.2 Mapinguari (or Juma)

The iemisch ('tiger of the water') of Patagonian folklore has tentatively been identified as the giant river otter, *Pteronura brasiliensis*, or a close southern relative thereof [23]. It is alleged that this represents a (former) range extension of the species. However, the number of digits on the feet of this alleged animal and the known otter differ. Other suggestions include a cultural composite of the otter and jaguar [13].

Traditions of the Tehuelche, Gennake, and Arauchan people of South America contain references to large burrowing animals with claws and tails. It has been suggested that these are accounts of Pleistocene ground sloths, e.g. *Megatherium americanum* and *Mylodon robustus* [23]. Indeed, archaeological artefacts made of giant sloth bones in central Brazil [34] give some

plausibility to the idea that tradition may pass down accounts of long-extinct animals over many generations in a form of cultural memory. Radiocarbon dating of ground sloth dung deposits show these animals were extant circa 10,000 years BP [25], contemporaneous with people in South America. Dating of poorly preserved specimens and stratigraphy-based techniques have suggested giant sloth survival up to 5,000 years BP, though these are controversial [13].

Upon coming into possession of a skin specimen studded with bony ossicles in 1898, paleontologist Florentino Ameghino entertained the possibility of ground sloth survival into the present, assigning the binomen *Neomylodon listai* to the alleged animal in a formal description [13]. However, Plata Museum of Natural History director Francisco Moreno concluded that the skin was not recent, just very well preserved, rendering *N. listai* a synonym for the known form *Mylodon darwini*.

Biologist David Oren also suggested the possible survival of remnant ground sloth forms into recent historical times (even the 1970s), based on accounts of one such alleged animal, the "mapinguari' or "juma", "not unlike the Yeti of Asia or big-foot of the Pacific Northwest" [31, 32]. Oren suggested that eyewitness descriptions of this alleged animal, including long coarse fur, clawed manus, and monkey-like face, are consistent with reconstructions of megalonychids and mylodontids, and pondered whether the creature is recently extinct or even extant and highly endangered. However, Oren concedes that "not all the evidence is consistent with a ground sloth" [32]. Similar suggestions have been made about the "segamai" tradition of the Matsigenka people [43]. The possibility that ground sloths survived the Quaternary "overkill" [40] is not generally accepted, and expeditions to the basins of Amazon River tributaries where reports originate have yielded only ambiguous molds of alleged tracks [13].

The probability of discovering ground sloths extant is now infinitesimally small, but other forms originally known only from fossils have been discovered extant in South America. In the 1970s, the Chacoan peccary *Catagonus wagneri*, a pig-like ungulate, was formally described as extant on the border of Paraguay, Brazil, and Argentina by mammalogist Ralph Wetzel [55]. This animal was previously presumed extinct, known to conventional science only from Pleistocene subfossils discovered in 1930 [1], though its existence in the present was an "open secret" among indigenous hunters [14].

5.3 Sivatheres (and Okapi)

Besides ground sloths, the persistence of other Pleistocene mammals beyond generally accepted extinction dates has been suggested. The sivatheres (prehistoric giraffes) are thought to have become extinct in the Calabrian stage of

the Pleistocene, with the most recent specimens dated to at least 700,000 years ago [6]. However, vertebrate paleontologist Edwin Colbert [7] drew attention to a Sumerian copper chariot ring from 3,500 BCE, excavated during the Field Museum-Oxford University Joint Expedition in Kish, Iraq. A statuette on the ring depicts an ungulate with missing cranial appendages. Colbert suggested that this statuette did not depict a cervid (deer) as first presumed, but a remnant sivathere, having survived into the Holocene.

Paleontologists Robert Savage and Michael Long similarly suggested that a petroglyph from 6,000 BCE in the Tibesti mountains of the central Sahara may depict a surviving sivathere [41]. Holocene archaeological artefacts with "sivathere-like" qualities in the British Museum, London, have also been described by paleontologist Christine Janis [17]. More recently, in 2009, petroglyphs from the Upper Paleolithic allegedly depicting sivathere forms were discovered in central India [30].

These "paleocryptozoological" suggestions have been met with some criticism. Details of these artefacts seemingly consistent with extinct forms may be attributed to artistic license and stylization by the ancient artist [49]. The pseudo-sivatheres have alternatively been identified as the Persian or Mesopotamian fallow deer *Dama mesopotamica* [45]. The same reidentification was made for Colbert's statuette, whose missing cranial appendages were later discovered in a museum storeroom [37], though Janis [19] has defended Colbert's sivathere based on antler and ossicone homology, as well as other characteristics of the statuette besides the cranial appendages.

Just two species of giraffid are extant: the giraffe *Giraffa camelopardalis* is the most well known of the two, while the lesser-known okapi *Okapia johnstoni* has a more cryptozoological history. The okapi was long-familiar to the indigenous people of central Africa, and variously called "atti", "Ndumbe", or "okapi" [23]. Its first informal descriptions by European colonial administrators in the 1860s described the animal as horned and donkey-like. The animal, representing both new genus and species, was only formally described when physical materials (skin and skull) were shipped to the British Museum in 1901. Like the coelacanth, the okapi is remarkable; first because it is another case of an ethnoknown animal evading formal description for decades, and second because it represents an extant genus with similar morphology to extinct forms, e.g., the Miocene giraffids *Palaeotragus*. Furthermore, its discovery for conventional zoological science was facilitated by traditional ecological knowledge; it was Congolese Pygmies who enabled Johnston and Erikson to make their "discovery" [20, 42, 21].

It has been speculated that an Achaemenian frieze at a Persian palace from 2,500 years BP may depict an okapi or similar giraffid [2]. If true, this would either represent range extension of the okapi or survival of another (similar) form into historical times in Iran [36]. However, Janis [18] points out that, being specialized browsers, okapi (and similar forms) were unlikely to have survived in Iran. The frieze animal has been alternatively identified as the extant nilgai antelope, *Boselaphus tragocamelus* from India [52].

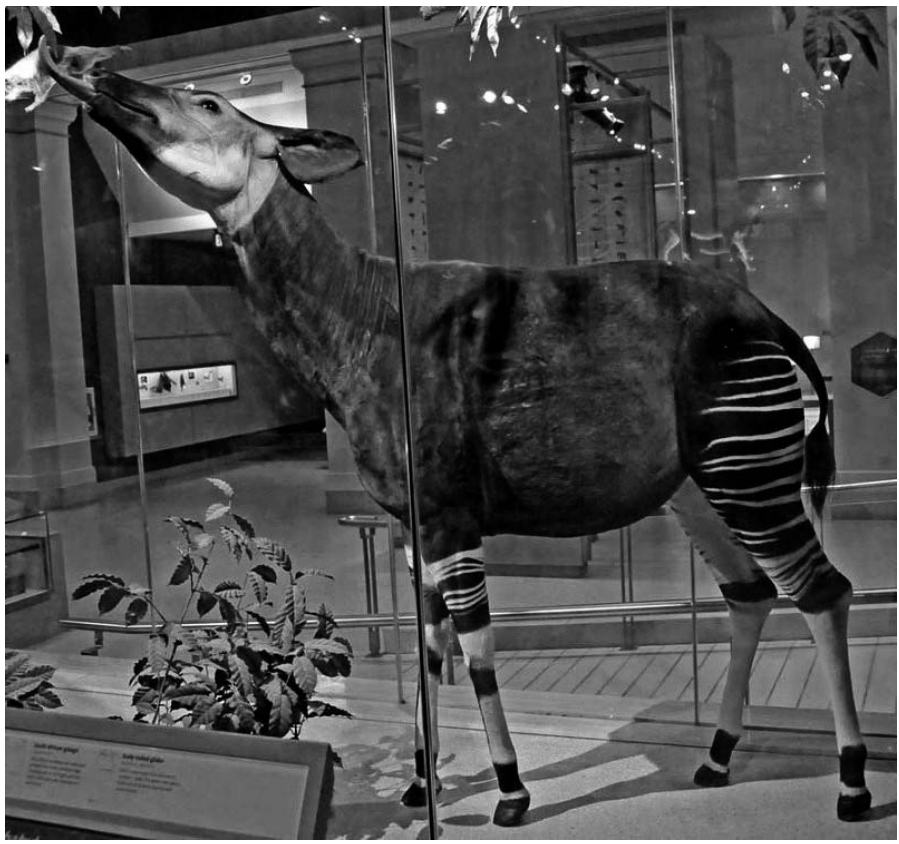

FIGURE 5.3
The okapi *Okapia johnstoni* is a living fossil whose discovery was facilitated by traditional ecological knowledge; the prototypical cryptozoological success story. Photo of okapi at the Smithsonian National Museum of Natural History in Washington, D.C. from the Smithsonian Open Access library [50], licensed under CC0.

5.4 Thylacine (or Tasmanian Tiger)

Aside from Pleistocene mammals, much has been speculated about recently extinct Holocene Mammalia. Most notable is the thylacine, *Thylacinus cynocephalus*. This fox-like marsupial, known variously as the Tasmanian tiger or Tasmanian wolf, was once native to New Guinea and mainland Australia, where it is thought to have become locally extinct circa 3,090 years BP [3]

(possibly related to competition with the dingo *Canis dingo* [15]). The last thylacine population persisted on Tasmania, where it was hunted down to the last verified living member, a resident of the now-defunct Beaumaris Zoo in Hobart, which died from neglect in captivity in 1936 [33]. The remains of this individual were lost until 2022, when they were found in a cupboard at the Tasmanian Museum and Art Gallery [53]. Since the death of the Hobart Zoo specimen, no living thylacine has been obtained, though the species probably did persist in vanishingly small numbers in the wild for some time thereafter.

Despite lack of physical material, supposed sightings of thylacines in Tasmania, and to a lesser extent, mainland Australia and New Guinea, have continued to the present. University of Tasmania zoologist Eric Guiler reported having witnessed thylacine spoor and kills in Tasmania in the 1970s and 80s [15]. Guiler also tabulated over 60 reported sightings, rated by reliability, including a possible thylacine sheep killing in the 1950s [15, 16].

In the early 1980s, tracker Kevin Cameron, hired by the Agricultural Protection Board of Western Australia, purportedly photographed a live thylacine digging at the base of a tree. These findings were published in *New Scientist* [9]. However, the photographs have been seriously criticized or dismissed by researchers including Guiler [15], who presented alternative possible evidence for thylacines on the mainland. Athol Douglas, scientific staff member of the Western Australian Museum, alleged extreme secretiveness by Cameron and lack of cooperation, as well as the film reportedly having been cut with frames missing [8]. Rather than a hoax, Douglas alleged that the Cameron photographs depict a real thylacine, but a deceased specimen in *rigor mortis*. The thylacine has been under official protection since 1936, so hunting this animal is a punishable offence, which may explain Cameron's behaviour. In contrast, marsupial expert Malcolm Smith [44] suggests the subject of the Cameron photographs is merely the carcass of a short-haired dog breed with painted stripes, noting the lack of tapered hindquarters. The hoax hypothesis is supported by paleozoologist Darren Naish [29], who also discussed the possibility that the subject photographed was a deceased banded hare-wallaby, *Lagostrophus fasciatus* [28], though that animal is typically smaller than the apparent size of the Cameron photograph subject.

Douglas also reported on a desiccated thylacine carcass recovered in 1966 from the Thylacine Hole cave at Mundrabilla Station by the Western Australian Museum [8]. Carbon-14 dating suggests the Mundrabilla Station specimen died approximately 4,500 years BP [22], but Douglas proposed that the specimen was only months old at the time of discovery, having not fully dehydrated, being covered in a tarry substance Douglas identifies as recent adipocere (a decomposition product) and surrounded by blowfly pupal cases and faeces. Douglas contends that the carbon dating result was due to contamination of the dry tissues by ground-water and suggested that bone samples should be tested instead. Smith [44] and Naish [27] have similarly criticized this suggestion, and as of 2023, no further examination of the specimen has been published.

More recently, the Thylacine Awareness Group of Australia (TAGOA) has collected numerous purported sightings and photographs from both the mainland and Tasmania. In 2008, a video of a limping mammal resembling a thylacine was recorded at dusk in South West Victoria [46], and in 2016, another mammal was recorded in South Australia [47]. Because of the low resolution and colour depth of these videos, stripes and other features are not clearly visible, making identification ambiguous. Some commentators have suggested that the animals pictured are foxes with mange. Mammalogist Catherine Kemper said the subject of the footage "could really be anything... But you never know... It would be arrogant if I said there was no chance" [10].

In 2021, TAGOA president Neil Waters published several photos taken with a digital trail camera in Tasmania, one depicting an animal with round ears at night, and the other a daytime photograph depicting the rear end of a mammal [48]. Conservationist Nick Mooney of the Tasmanian Museum and Art Gallery alternatively identified the animal pictured as a Tasmanian pademelon, *Thylogale billardierii* [39].

In 2023, an international team of researchers used an exhaustive dataset of over 1,200 confirmed and possible thylacine encounters in an extinction dynamics model to infer a probable extinction date for the species. Results of sensitivity testing placed the probable extinction as recently as the late 1980s to early 2000s [5].

Plans have been made to revive the thylacine, though none have yet come to fruition. Among the first of such proposals came in 1999, when mammalogist and Director of the Australian Museum, Michael Archer, announced plans for geneticists to extract viable DNA from ethanol-fixed tissues of a baby thylacine born in 1866, and to use the Tasmanian devil, *Sarcophilus harrisii*, as the surrogate mother [4]. Epigeneticists later isolated a transcriptional enhancer element from the thylacine genome and examined the function of the enhancer in vivo with transgenic mice [35]. The full nuclear genome of a thylacine pouch young was sequenced in 2018, with reads mapped to the Tasmanian devil genome [11]. This revealed a long-term decline in thylacine genetic diversity since before human arrival in Australia.

The University of Melbourne announced in 2022 the creation of the Thylacine Integrated Genomic Restoration Research Lab (TIGRR) with $5 million in philanthropic gift funding and a $10 million grant from biotech firm Colossal Biosciences [24]. TIGRR's aims are to improve the quality of the thylacine genome (and obtain a whole functional genome), refine methods for the derivation and maintenance of marsupial stem cells, and develop assisted reproductive techniques in marsupials, with the hope of one day returning the thylacine from extinction [51]. While some believe that the recreation of organisms with at least partial genomic similarity to their extinct relatives is possible within the not too distant future [38], others are far more skeptical that such technologies will ever materialize, and yet others have denounced thylacine resurrection efforts as "a product of continued anthropogenic hubris" [54].

Although the thylacine is probably no longer in the extant biota, there are surely many other land mammals still undescribed. Giam et al. [12] note that the discovery rate of land mammal species has been relatively constant since the year 1850, and these authors estimate that approximately 163 previously unknown land mammals will be discovered in the years to come, almost half in the neotropics of the Americas.

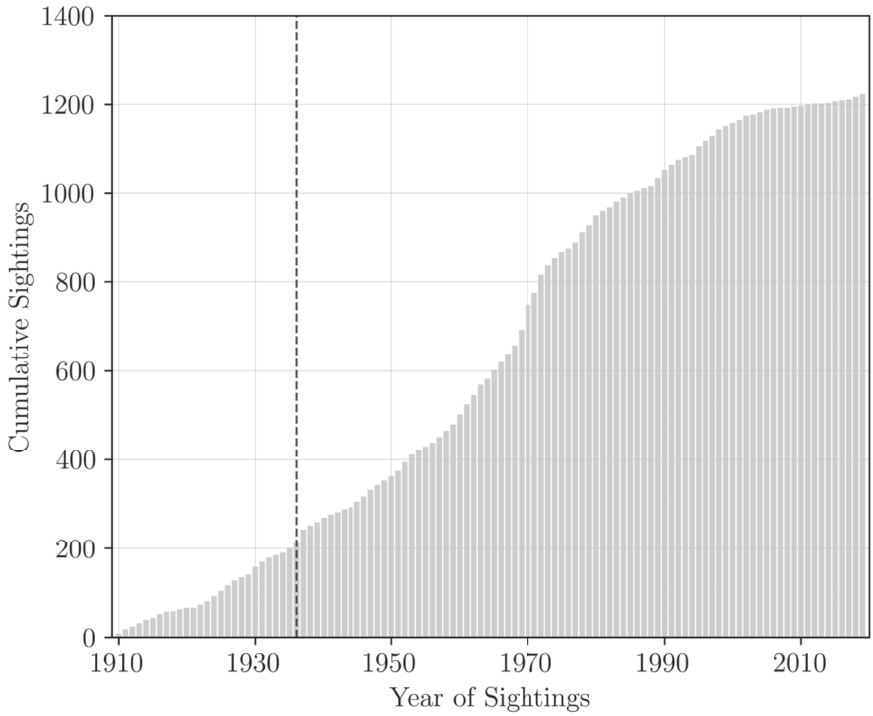

FIGURE 5.4
Cumulative sightings of thylacines in Tasmania number over 1,000. The vertical dashed line indicates the year in which the last verified living member died in 1936. Data from [5]. Figure by Floe Foxon.

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6

Lake "Monsters"

Across history and cultures, folkloric traditions have described many lake-dwelling animals, a number of which are purported to be large in size and located in the Northern Hemisphere [49]. On occasion, mythical monsters of rivers and lakes have subsequently been identified as real (known) forms. For example, the "White River Monster", which frightened and confused residents of White River in Newport, Arkansas from the 1930s through to the 70s, has been identified as the Florida manatee *Trichechus manatus latirostri* [55] (Mackal's elephant seal hypothesis [43] is not particularly likely because that animal is found along the opposite seaboard [86]). Others, such as the "Silver Lake Monster" have been revealed as hoaxes [43], and yet more have persisted "unidentified", often amid intense debate.

6.1 Loch Ness Monster (or Nessie)

The Loch Ness monster or "Nessie" is exemplary of this phenomenon. Nessie is a reported inhabitant of Scotland's Loch Ness, a freshwater loch formed by erosion along the Great Glen Fault [74]. The Official Loch Ness Monster Sightings Register contains over 1,100 sightings as of 2023 [9]. The earliest reported sighting dates back to 565 CE, but this "Saint Columba" sighting has been seriously criticized as religious propaganda [81].

Besides eyewitness reports, before 1965, the evidence presented for the existence of an unknown animal in Loch Ness was mostly photographic. The three most widely circulated early photographs (available in [25]), namely the "Hugh Gray Photograph" (1933), "Surgeon's Photograph" (1934), and the "Lachlan Stuart Photograph" (1951), show features on or in water that are difficult to interpret due to the darkness or blurriness of the subject and because it is not possible to ascertain their size; there are no other objects in these photographs to serve as accurate references.

Surgeon's Photograph in particular was cropped before publication, which made the subject appear larger [10]. Oceanographers Paul LeBlond and Michael Collins estimated the size of the subject in Surgeon's photograph, first by counting the number of water wavelenths it spans, and then by estimating the wavelength in meters based on wind speed [39]. The estimated

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size of the subject was 1.21 meters, though LeBlond and Collins noted that shorter or longer wind durations could change their estimate to 0.6 meters on the lower end and 2.4 meters on the upper end. Science writer Steuart Campbell contested the 22 kilometer wind fetch used in this calculation, arguing a much shorter fetch was involved, and therefore a smaller object [12]. This was contested by Leblond [38]. It was later alleged that the subject was a model neck and head affixed to a toy submarine [48], rendering any argument about wavelength irrelevant; the photo may have been taken on a different day with unknown wind speed.

Films have also been presented. The "Dinsdale Film" of 1960 appeared to show a long object moving across the loch [14]. A "Photographic Interpretation Report" of the film by the Joint Air Reconnaissance Intelligence Centre (JARIC; the national strategic imagery intelligence provider) concluded that the subject filmed was probably an animate object [40]. Image stacking analyses to reduce the noise of the original film reveal features that may represent the license disc and helmsman of a boat, rather than an animal [73, 61]. Furthermore, the speed calculations in the JARIC report have been criticized, e.g., for not accounting for the winding times of the camera motor [11].

Due to the inconclusive and temporally "scattered" nature of these early films and photographs, systematic investigations of the loch were necessary. The first such investigations were undertaken by the Loch Ness Phenomena Investigation Bureau (LNPIB), co-founded by ornithologist Sir Peter Scott and Member of Parliament David James, and later directed by Mackal.

From 1965 to 1966, "Operation Bootstrap" saw the use of surface surveillance (binoculars) and photography, capturing only inconclusive observations, else known animals such as birds [42]. A scientific seminar was held in Pittsburgh to share these findings with zoologists.

In 1967, photographic efforts were expanded and a surface craft was employed [42]. The results were the "Raynor film" (a surface disturbance that has been attributed to a family of fish-eating duck [60]); and the "Matheson sighting" (attributed to standing waves formed by boat bow waves reflected from the loch shores).

In 1968, a two-week sector-scanning sonar survey was implemented, which measured possible diving profiles of objects "several yards in length" [42]. An article describing these findings was rejected by the journal *Nature*, but was published in *New Scientist* [6]. Controversially, *Nature* subsequently published a "news and views" editorial criticising the sonar instruments that had been used by asserting that said equipment was prone to artefacts in testing [53]. This editorial was rebuked as "the armchair views of one man" in a subsequent *Nature* correspondence [3].

Also in 1968, a biopsy harpoon and crossbow for tissue sample collection and subsequent histological and biochemical analyses were prepared, but never used [42]. Funding and equipment sources included the New York Aquarium, the University of Birmingham, and The Adventurers Club of Chicago.

In 1969, two submersibles with sonar capabilities (one also rigged with biopsy harpoons) entered the loch [42]. One sonar signal measured an apparently moving object, but visual confirmation was not obtained. A mobile sonar probe similarly made unconfirmed contact with a moving object for approximately three minutes. Longlining and trawling were also attempted without significant result.

In 1970, following a scientific seminar at the Massachusetts Institute of Technology (MIT), baited underwater cameras were rigged and acoustic monitoring of the loch was performed with anchored hydrophones [42]. Besides outboard boats, unidentified "bird-like chirps", "clicks", "knocks", and "swishing" sounds were recorded. Photographs pictured only the baited line, small objects, or else nothing at all. Further sonar echoes were shared via press conference; none were identified or confirmed visually. Baited traps collected many specimens of European eel *Anguilla anguilla* with skewed size distribution. Mackal interpreted this as evidence that very large eels may exist in the loch [42], but the distribution was skewed toward smaller eels rather than larger ones ([18]; more on this later).

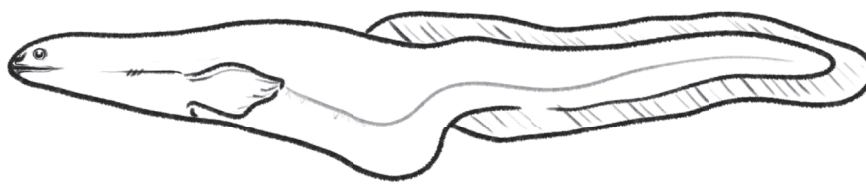

FIGURE 6.1
Loch Ness' giant eel, hypothesized by Mackal [42], after C. S. Wellek. Summer Matthews drawing.

Between 1972 and 1982, the Academy of Applied Science (AAS; led by inventor Robert Rines who had attended the LNPIB seminar at MIT [42]) undertook several operations at the loch [64]. A dozen or so sonar "sightings" were published, purportedly inconsistent with fish shoals and boats [30, 64]. For the first time, sonar results were supported by simultaneous strobe camera photography, with image enhancement performed at the Jet Propulsion Laboratory, California Institute of Technology. The resulting images are of low quality, such that interpretation is ambiguous, but have been described as "flipper", "full body", and "head" shots [64]. Some of these images were presented at a press conference in the Palace of Westminster or Houses of Parliament in London, in collaboration with the journal *Nature*. Simultaneous sonar and hydrophone recordings were also reported [65]. Optical data suggest the "flipper" object to be approximately two meters in size, which, in a plesiosaur-like configuration, would provide a total body length of 15–20

meters [69]. However, the original, unedited "flipper" image, sans "enhancement", appears to show only silt.

As a result of the preliminary evidence accumulated by 1975, an article published in *Nature* proposed for Nessie the binomen *Nessiteras rhombopteryx* to ensure that, should the animal exist, it would be protected by the UK's Conservation of Wild Creatures and Wild Plants Act of 1975 [69]. As an aside, *Nessiteras rhombopteryx* is perhaps coincidentally an anagram of "monster hoax by Sir Peter S' [51]. The binomina *Megalotaria longicollis* [26] and *Nessiesaurus o'conneri* [42] were suggested a decade earlier, making *N. rhomobpteryx* a junior synonym, though none of these three are demonstrably valid. *N. rhomobpteryx* advocates have at times included curator of reptiles and amphibians at the Smithsonian National Museum of Natural History, George Zug [87], and Deputy Keeper of Zoology at the Natural History Museum, London, Maurice Burton [8].

Speculative identifications for Nessie include a modern relative of the armoured prehistoric fish *Pterichthyoides milleri*, fossils of which have been found near Loch Ness [41]; extant plesiosaurs, marine reptiles of the Mesozoic Era, some of which were freshwater [7]; the beluga whale *Delphinapterus leucas*; and drifting masses of peat [52].

The "head" shot photograph [64] has variously been identified as the carved dragon head of a sunken Viking vessel or as the decomposing head of a stag or Highland cattle bull [87].

Fieldwork by the AAS continued in 1984 through to 1989 with surface-facing silhouette cameras, though no unknown animals were photographed [66, 16].

Proceedings of the Loch Ness Monster symposium, held at the National Museum of Scotland in 1987, were published by The Scottish Natural History Library [21, 22]. At this symposium, Mackal suggested the most likely classes of animals to which Nessie may belong are the Mammalia (possibly a primitive cetacean) and the Pisces (possibly a giant eel). This determination was based on a reports of an elongated head-neck configuration, one pair of pectoral flipper-like organs, dark integument, supposed sizes of one to 15 meters, and locomotion at eight to 16 kilometers per hour.

In another symposium presentation, naturalists Adrian Shine and David Martin of the Loch Ness and Morar Project (LNMP) pointed out that if Nessie was a mammal, it would need to surface more frequently to breathe. This surfacing problem was presented 27 years earlier by Burton [8]. Shine and Martin further noted that most sightings occur in bays around river mouths, and that eels migrate via the River Ness.

Results from "Operation Deepscan", a sonar curtain sweep of the loch, were then reported. In over 2,500 hours and 4,000 kilometers of search, three non-fixed contacts were made, which remain unexplained. One was exceptionally strong and deep at a depth of approximately 174 meters. Also during this operation, Osprey low-light-level underwater cameras were employed to examine loch bed contacts. One photograph of an underwater tree stump presented

FIGURE 6.2
It has been suggested that Nessie and other lake monsters are living plesiosaurs. Photo of short-necked plesiosaur *Dolichorhynchops bonneri* at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania by Floe Foxon.

at the symposium resembled the "head" shot of the AAS, casting doubt on the interpretation of the latter photo as a live animal.

Some features of Loch Ness make it ideal for supporting larger lifeforms. For example, the loch itself is large; its greatest depth is over 200 meters and its length is over 30 kilometers [24]. The lake is oligotrophic (deficient in plant nutrients, often accompanied by abundant oxygen), features a complete biological cycle, and is cold but does not freeze in Winter [42].

However, the biomass necessary to sustain a population of large aquatic animals is high, whereas the annual fish yield of Loch Ness is estimated at 0.55 kg ha^{-1} yr^{-1} [70], which is at the low end of the fish yield distribution of lakes [59]. In an article "written for fun", Sheldon and Kerr [70, 71] used a standing fish stock of 0.55 kg ha^{-1} to estimate a "monster" population of 156 if the individual monster mass is 100 kg, and a population of just one if its mass is between 2,000 and 3,000 kg. This fish stock value is consistent with (actually slightly lower than) other estimates [76, 34].

Scheider and Wallis, with different methodology, similarly estimated loch populations of 157 for 100 kg animals, and 10 for 1,500 kg animals [68].

However, whether these ocean-based methods can be applied to Loch Ness is not known. Shine [72] points out that these monster masses are not very monstrous, and translate to around ten European sea sturgeon *Acipenser sturio*. A tiger shark of approximate mass 3,000 kg was allegedly caught in China in 1957 [17]. If Loch Ness featured a monster with similar mass to this tiger shark, it could only feed a single specimen.

In *Nature's* 1976 Christmas issue, Carl Sagan applied collision physics to the problem, an approach that is independent of biomass calculations [67]. Sagan estimated a loch population of 300 animals of size 10 meters with velocity 3 m s^{-1} if the mean free time for collision (the average time taken for a monster to be seen by an observer, based on the AAS studies) is 3×10^4 seconds.

In 2018, the Loch Ness Project collaborated with numerous universities to collect and analyse environmental DNA from the loch. Indirect collection of mtDNA and nuDNA transferred from faeces, gametes, and carcasses into the water was undertaken [75]. 250 samples collected to a maximum depth of 200 meters from both north and south basins of the loch contained significant quantities of eel DNA. Notably, no DNA was found from large fish including sharks, catfish, or sturgeon, and indeed no large reptile DNA was sampled (this precludes the plesiosaur hypothesis). According to geneticist Neil Gemmell who led the eDNA survey, "our data doesn't reveal their size, but the sheer quantity of the material says that we can't discount the possibility that there may be giant eels in Loch Ness" [84].

Shortly after the eDNA study findings were published, the Ness Fishery Board filmed a large, eel-shaped object in the River Ness [83]. The author has applied probability theory to Loch Ness eel catch data, demonstrating that the probability of finding an eel upwards of one meter in length at Loch Ness is reasonable given the known fish stock, but the probability of finding a truly monstrous eel two meters or larger is vanishingly low [18]. Therefore, while eels may account for some sightings at Loch Ness, they are most likely not the giants that have been hypothesized.

Ronald Binns [5] concludes that despite decades of intense effort, attempts to find a monster in Loch Ness have not succeeded in doing so. Binns suggests that "the great appeal of the Loch Ness mystery is perhaps the way in which it offers everyone the chance to become an amateur sleuth, pore over the evidence, visit the dark mysterious waters, and concoct a new theory about what it is which has baffled the world for so long."

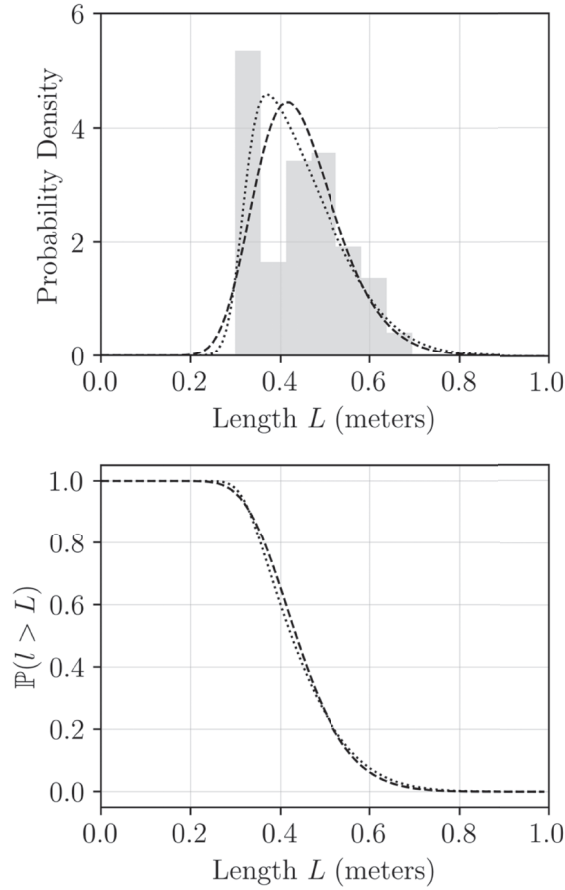

FIGURE 6.3
Distribution of lengths of European eels (*Anguilla anguilla*) in Loch Ness (upper) and probability of finding an eel of length $> L$ (lower) for skew normal (dotted lines) and generalized extreme value (dashed line) fits. Data from [42]. Figure by Floe Foxon [18].

6.2 Lake Champlain Monster (or Champ)

Similar alleged animals to Nessie have been reported at other freshwater lochs, including Loch Morar [99] and Loch Shiel [92] in Scotland. In 1969, a large animal resembling the monkfish *Squatina squatina*, allegedly rammed a cruiser in Loch Morar, but no samples were obtained from the hull of the boat [42].

Lake Champlain in the US and Canada is another such monster lake, allegedly the habitat of an unknown aquatic animal dubbed "Champ" (or "*Belua Aquatica Champlainiensis*", *nomen nudum*). Champ has been speculatively identified as the archaeocete *Basilosaurus*, or even a plesiosaur [15], though the archaeocete hypthesis is based on now-outdated reconstructions of these forms, as in Mackal [43]. At almost 26 cubic kilometers, Lake Champlain holds more than three times as much water as Loch Ness [35, 54].

In 1977, a photograph of Champ (the "Mansi" photograph) was supposedly taken from the shore with an instamatic camera. Using the Beaufort scale, LeBlond [37] estimated the wind speed at the time the picture was taken from the appearance of waves on the lake surface, and used this along with an estimate of the fetch to calculate the wavelength of the waves, and thus the size of the subject. LeBlond's estimate for the size of the subject of the Mansi photograph was 4.8 to 17.2 meters. Of course, this does not distinguish between a lake animal or floating log of similar size. Mathematical physicist B. Roy Frieden [20] found no evidence of photographic tampering, but noted the possible presence of a sand bar which could indicate that the subject was placed in the water. Field experiments have also attempted to recreate the Mansi photograph: Radford estimates the subject size at 2.1 meters [56], while Raynor gives 1.3 meters [62].

Mirroring the LNPIB, the Lake Champlain Phenomena Investigation (LCPI), led by underwater archaeologists Mary Patram Meaney and Joseph Zarzynski, conducted fieldwork at Lake Champlain during the 1980s. The LCPI implemented sonar surveys, shoreline and vessel surface surveillance, scuba dives, and a remotely operated submersible to collect evidence for the existence of unknown animals in the lake [88, 89, 91, 93, 94, 95, 96, 97, 98]. This included "Project Champ Carcass", a six-day search of the lake bed. From 1982 to 1990, dozens of eyewitness anecdotes were collected, but no unidentified sonar targets were tracked by the LCPI, and no physical evidence was observed during dives. One "possible" surface sighting was made in 1982, and another in 1988, but none were made in other years. In 1987, the LCPI observed for the first time two deer swimming in the lake, which may account for some reported sightings.

Wind & Whalebone Media Productions developed underwater video cameras for Lake Champlain investigations [77]. After field tests were carried out in 1984, during which no recordings or sightings were made [77], subsequent investigations with video equipment and hydrophones yielded no

unidentifiable sights or sounds [78, 79]. Sonar surveys captured mostly fish, but on three occasions "larger marks" were noted, which were not identified [78].

Despite inconclusive findings, in 1986 the Vermont Senate followed the New York Senate in adopting the "Champ Resolution", calling for the protection of possible unknown animals in the lake. The LCPI was succeeded by Champ Quest, which undertook similar expeditions at Lake Champlain from 1991 [13]. Champ Quest documented dozens more eyewitness reports, as well as five "anomalous" sonar contacts, but no conclusive evidence was reported.

The author has studied Champ sightings statistically, showing in an interrupted time-series analysis that the publication of the Mansi photograph was associated with a statistically significant increase in purported sightings of Champ at the lake [19]. This may be evidence of "expectant attention', the tendency for observers to "see" what they anticipate they will see (i.e., a "monster") [58]. Futhermore, the author's analyses showed that sightings were highly inconsistent in reported Champ characteristics with widely varying morphology, and most sightings were missing morphological data entirely. More than a quarter of sightings were likened to logs, land mammals, birds, fish, and boats, which are all found in the lake. There were no associations between distance to sighting, estimated length, and estimated height of objects witnessed, which may suggest that eyewitnesses provide inaccurate estimates of these measurements in lake settings. Perhaps the most parsimonious explanation is that lake-goers mistake ordinary lake phenomena for Champ.

The Naitaka, anglicised as "Ogopogo", is another such supposed lake lurker, reportedly inhabiting Okanagan Lake in British Columbia, Canada [43]. Multiple reported sightings of this alleged animal were made in the 1970s [50]. In 1989, the British Columbia Scientific Cryptozoology Club (BCSCC) reportedly observed a large, humped animal from a distance during an expedition fielded at the lake, and in one instance recorded a "jittery" video of the phenomenon, the fate of which is not clear [27]. The BCSCC published additional annual field reports in 1990 and 1991, reporting only the sighting of a large fish [28, 29]. At least three purported films and video of "unknown" animals at Okanagan lake are consistent with otters or beavers [58].

The temporal distribution of purported unknown lake animal sightings has been studied. Most Champ sightings occur in the evening, which has been interpreted as evidence of nocturnality [31]. An alternative explanation is that low visibility in the evening makes observers more likely to confuse ordinary phenomena such as waves, logs, and known lake animals, with supposed unknown animals. Interestingly, while the distribution of sighting times for Lake Champlain is a skewed distribution with a single peak at 19:30, for Loch Ness and Okanagan Lake the distributions of sighting times are bimodal with peaks at 10:30 and 15:30/16:30 [32]. This may be interpreted as evidence of different behaviours by different lake-dwelling animals being sighted, but could also result from regularity of wind/wave effects [4], cultural differences, e.g., siestas [45], or from sampling error or other bias. Indeed, in the case of the coelacanth,

catch data says more about the habits of the Comorans who fish than the fish themselves [82]. Most Champ sightings also occur in July and August, which may be interpreted as evidence of seasonal heterothermy, but is also explained by seasonal tourism leading to more alleged sightings. Eyewitness reports of Champ locomotion and morphology are very conflicting, with both horizontal and vertical undulation reported, and a range of humps from just one to more than ten.

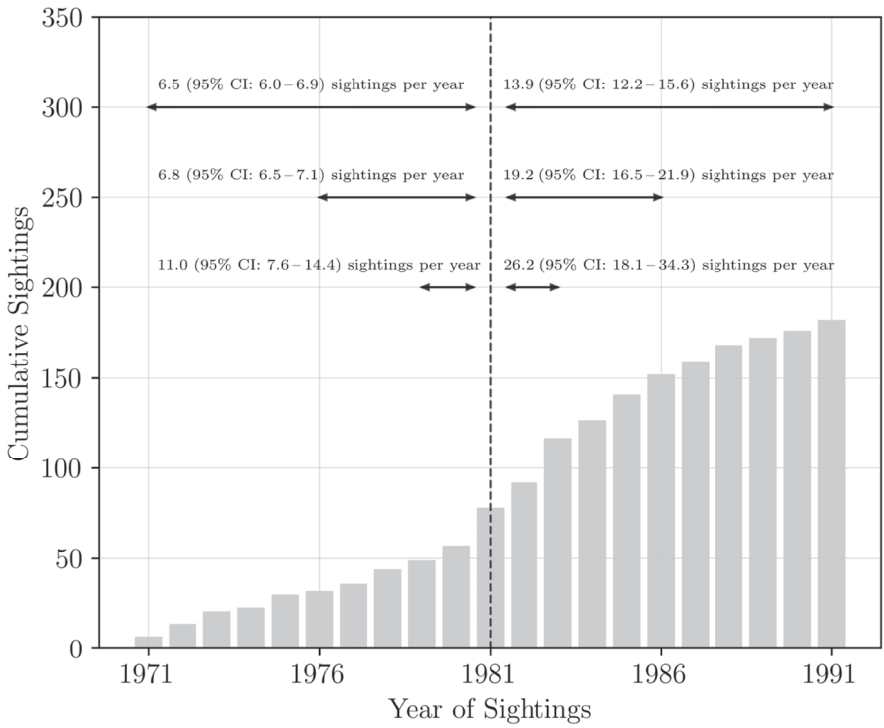

FIGURE 6.4
The number of Champ sightings per year increased significantly after the publication of the Mansi photograph. Data from [90, 13, 88, 89, 91, 93, 94, 95, 96, 97, 98]. Figure by Floe Foxon [19].

6.3 Mokele-Mbembe (or Living Dinosaurs)

Aside from claims of unknown animals in lakes of the Northern Hemisphere, swamp-dwelling animals are also alleged to exist nearer the equator. In the

Congo River Basin, particularly around Lake Tele in the Republic of the Congo, some indigenous people have reported the apparent existence a large, bulky, amphibious animal named Mokele-Mbembe ("one who stops the flow of rivers"), and whose long neck has been likened to sauropod dinosaurs such as *Diplodocus* [44].

Unlike Loch Ness which is connected to Moray Firth and the North Sea via the River Ness, and Lake Champlain which is connected (distantly) to the Gulf of St Lawrence and North Atlantic Ocean by the Richelieu and St Lawrence rivers, Lake Tele is landlocked some 800 kilometers from the South Atlantic Ocean, and is surrounded by freshwater swamp forest [36]. Lake Tele is also by far the smallest of the three bodies of water.

Nevertheless, claims of an unknown animal in and around Lake Tele have been investigated on various expeditions. Among the earliest accounts of the supposed inhabitant of the lake is a report from a German colonist in Cameroon in 1913 [43]. During the Percy Sladen Expedition in 1932, Ivan Sanderson and naturalist Gerald Russel reportedly observed a water-dwelling animal larger than a hippo, and leaving sauropod tracks, in a cave along the Mainyu river in West Cameroon. Sanderson ascribed the name "mbuluem'bembe" to this animal, a phonetic English rendering of the indigenous name. Herpetologist James Powell visited the region decades later, and learned from Mamfe locals that hippopotami use these caves as dens; hippopotamus tracks may be mistaken for sauropod tracks, especially when foot impressions are made in coarse-grained substrate that retains little information about the foot that left it.

An expedition in 1981, headed by Roy Mackal of the LNPIB, and including among its members J. Richard Greenwell, scouted the Likouala region surrounding the lake [46]. No observations or sonar recordings of unknown animals were obtained. A wake in the Likouala River and a disturbance leading to the river were observed, but because their cause was not witnessed, these are ambiguous. Proximate chemical analysis of the *Landolphia* fruit, which is purportedly consumed by the animal, was performed on samples obtained during the expedition. The analysis showed that this fruit alone would not be sufficient to provide the nutritive needs of such an animal [85].

The same year, The Regusters' African Congo Expedition (TRACE), led by Jet Propulsion Laboratory engineer Herman Regusters, published numerous findings [63]. Reported observations on this expedition include large perturbations on the lake surface, and five sightings of an unknown animal including a long, dark neck, and a smooth back, the latter being observed with binoculars at a distance of approximately one kilometer. On one occasion, the animal was allegedly witnessed by "every member of the scientific team, except the photographer" [63]. On others, "there were times when there were no cameras at hand" [63], and "the humidity destroyed all the film" [63]. A "low windy roar" was reportedly heard on multiple occasions, but "[a]ttempts to record the sound... resulted only in rather poor quality productions" [63].

Surface deposit samples were collected, "believed to be the aftermath of the passage of the strange animal seen in the lake" [63].

In 1983, the first Congolese expedition to Lake Tele was undertaken, led by biologist Marcellin Agnagna [1]. In agreement with observation from the TRACE expedition, Congolese expedition members reported witnessing an animal with a long neck, and a humped back approximately 2.6–3 meters in diameter, visible above the water of the lake at a distance of up to 300 meters. Once again, the animal was not photographed, this time because "the camera was accidentally set on macro" [23].

During the Congolese expedition, Agnagna also reported "frequent observations of a large turtle, with a shell reaching 2 meters in length" [1]. Amateur palaeontologist Glen Kuban pointed out that precisely this turtle, swimming in the lake with its long neck and head pointing upwards, would perfectly explain the profile of Mokele-Mbembe described by Agnagna and Regusters [33]. This could perhaps be the African softshell turtle *Trionyx triunguis* (or a closely related animal) found in West Africa, which is both large and long-necked. Furthermore, some Mokele-Mbembe reports claim the animal features a single tooth or horn on its head [43], which may be accounted for by the pointed nose of *T. triunguis*. Regusters also stated that "[t]he hump was a distinctive feature," which would also seem to confirm the large turtle hypothesis, but continued "it is not as someone else said, a large turtle with a long neck," despite the nearest sighting being at a long distance of approximately 60 meters [63].

Indeed, on the duration of these sightings, Regusters states that "[m]ost of them were over a good length of time except the one close sighting" [63]. Agnagna also responded that the animal observed could not have been a turtle because "turtles do not surface with their necks extended in such a manner" [2]. In 1984, Agnagna did not have the internet to verify such a claim, but a simple on-line search today shows that turtles have indeed been photographed swimming in such a manner.

A follow-up expedition was undertaken by Congolese and Japanese members in 1988 [80]. No sightings were made by expedition members, but one Boha local described how forest elephants raise their trunks above the surface of the water when crossing rivers, which may account for some Mokele-Mbembe sightings.

More recent expeditions to the Congo have been undertaken by the BCSCC in 2001, National Geographic in 2006, and the History Channel in 2009, all without autoptical evidence for Mokele-Mbembe [47]. In 2012, a crowd-funded project amassed almost $30,000 to mount a Congo expedition in search of the lake monster, apparently returning empty-handed [57].

FIGURE 6.5
Mokele-Mbembe has been likened to a sauropod dinosaur. Photo of the sauropod *Apatosaurus louisae* at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania by Floe Foxon.

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7

Sea "Serpents"

One of the primary criticisms of lake "monsters" is that most lakes are not nearly large enough or sufficiently abundant in food to sustain a minimum viable population of sizable unknown animals. This is not true however of the Earth's seas, which were once rife with giant marine reptiles including the plesiosaurs, mosasaurs, ichthyosaurs, and crocodiles. Unsurprisingly, many large, hidden animals are reported to exist in the seas of the present.

7.1 Ri (or Mermaid)

Mermaids are a geographically widespread folklore. In 1755, antiquarian Erik Pontoppidan described "sea-men" and "sea-women" in the North Sea based on eyewitness testimony alone [39]. Mermaid-like animals have also been reported by the indigenous people of the island province New Ireland, Papua New Guinea: The "Ri" (in Barok), "Ilkai" (in Susurunga), or "Pishmeri" (in Tok Pisin) has been described by locals as a marine animal, light brown in colour, with a human-like upper-half (including a human-like face and two arms), and a lower-half terminating with flukes [56]. Ri had allegedly been captured both dead and alive by the islanders, but always these resulted in release or consumption, such that no specimens were ever retained for scientific examination [56].

Anthropologist Roy Wagner conducted fieldwork in New Ireland in 1983 by interviewing the villagers [58]. It was noted that some of the Barok people identified bones of the dugong *Dugong dugon*, a rare marine mammal, as belonging to the Ri, while others considered the Ri to be distinct from the dugong, which they called bo narasi ('ocean pig'). Dugongs, like the Ri, have fluked tails and somewhat human-like heads (two small, wideset eyes; two nares; whiskered, flat snouts; and molar teeth). While the dugong has two paddle-shaped flippers, the Ri is said to instead have arms terminating with fingered hands. This may be explained by the skeletal remains of the dugong; like manatees, dugong flippers contain five vestigial finger bones. Thus, an islander discovering these may reasonably deduce that the Ri has human-like hands.

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During the 1983 expedition, an unknown animal (identified as the Ilkai by the Susurunga people) was photographed from a distance by expedition members in Nokon bay. Its head was not observed sufficiently for identification purposes, but consistent with the dugong, the animal had mammalian flukes and no dorsal fin. The animal also surfaced regularly by rolling sharply with a period of 10 minutes. Attempts to capture the animal by net were unsuccessful.

FIGURE 7.1
Like terrestrial mammals, the flippers of marine mammals feature vestigial finger bones similar to those of the human hand. Photo of marine mammal "fingers" at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania by Floe Foxon.

Marine mammalogist James Mead [32] and marine biologist John Sibert [46] advocated for the dugong hypothesis, while marine biologists Richard Ellis [9] and Kelvin Britton [5] favoured the Ri as a cetacean. The expedition members, however, were not fully persuaded by either suggestion [57, 13], noting that the animal they observed appeared to be a piscivore, preying on nearby fish, whereas dugong consume mostly seagrasses. They also believed the dive duration of 10 minutes to be inconsistent with the dugong, and that other features such as the colour and vertical flexure of the animal were not entirely cetacean-like.

The matter was settled in 1985, when members of the Ecosophical Research Association (ERA) took high-quality underwater photographs of the animal in Nokon Bay, again identified as the Ilkai by the Susurunga people [60]. These photographs indisputably revealed that the Ri and the dugong were one and the same animal after all. The apparent fish hunting behaviour observed in the previous expedition was likely mistaken, and unknown to the expedition members due to limitations in the dugong literature of the time, dugong are now known to dive for as long as 12 minutes, consistent with observations [7]. This result was welcomed by Greenwell [14], who stated that the discovery was "made possible by cryptozoological fieldwork, not mere armchair explanations".

Mermaid myths elsewhere in Oceania, Europe, Asia, and Africa have also been attributed to encounters with sirenians [21, 6]. This includes Roman-occupied France, where fossil remains of the extinct dugongid *Halitherium* were reconstructed as the merpeople they called "Nereids" and "Tritons" [30].

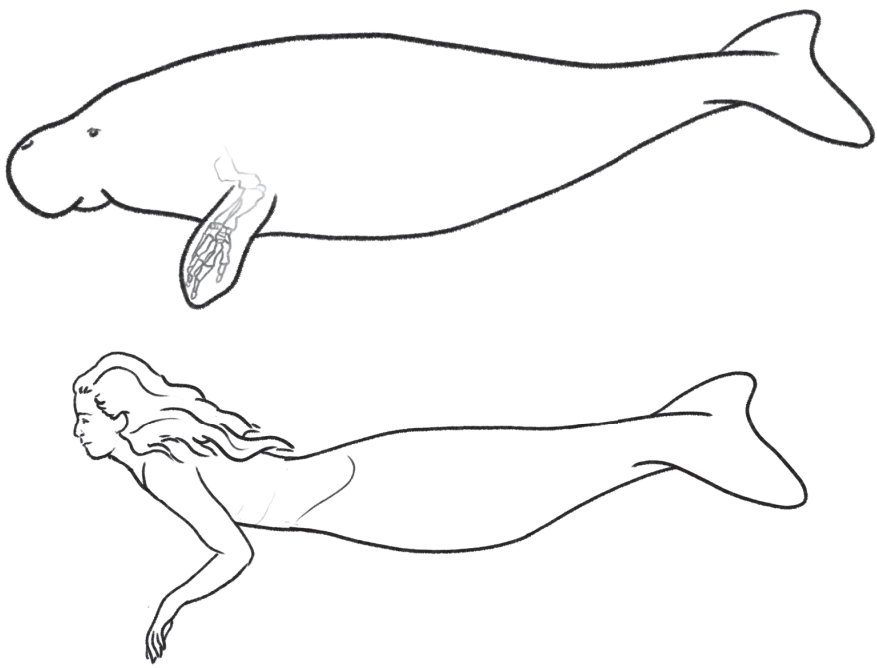

FIGURE 7.2
Top: Silhouette of a sirenian with vestigial finger bones, after McNiven [31], redrawn with permission from McNiven. Bottom: Reconstruction of the sirenian as a Mermaid. Summer Matthews drawing.

7.2 Kraken (or Colossal Octopus)

Myths of massive cephalopods have persisted for centuries. As documented by statistician and fish biologist Charles Paxton [36], Pontoppidan [39] discussed the monster of Scandinavian folklore known as "the Kraken" as a possible "polype" (octopus) or even "of the Starfish kind." An enormous cephalopod was given the binomen *Microcosmus marinus* in early editions of Carl Linnaeus' *Systema Naturae* [18].

Another such alleged animal is the so-called Florida Monster, which has (at somewhat of a stretch) been connected to the Lusca sea monster of Caribbean folklore [27]. Discovered on St. Augustine beach, USA in 1896, this "monster' was a bulbous, poorly preserved carcass, seven meters long and with an estimated mass of over 5,000 kilograms.

The presumed identity of the Florida Monster has alternated considerably over time. At the time of its discovery, president of the St. Augustine Scientific Society DeWitt Webb identified the monster as a cephalopod, namely a giant octopus. In January 1897, invertebrate zoologist Addison Emery Verrill [54] of Yale University instead identified the remains as those of a giant squid. The next month, after receiving additional photographs and description, Verrill [51] revised his identification to align with Webb's giant octopus, and formally described the remains as the holotype of a new 30-meter species, *Octopus giganteus*. The month after that, Verrill [52, 55, 53] retracted *O. giganteus* after examining two tissue samples preserved in formaldehyde. Verrill decided instead that the remains belonged to a cetacean, most probably a sperm whale, an opinion ratified by zoologist Frederic Augustus Lucas of the Smithsonian National Museum of Natural History in Washington, DC.

Years later in 1957, biologist Joseph Gennaro of the University of Florida performed a histological analysis of the Smithsonian samples, comparing connective tissue patterns under polarized light to controls [61]. In an article rejected by *Science* and later published in the American Museum of Natural History's *Natural History* [12], Gennaro concluded that the sample was not whale blubber, but octopus tissue after all. Further biochemical analyses were performed by Mackal and biologist Paul Rancurel, who compared the amino acid composition and copper and iron concentrations of Florida Monster samples to cetacean and cephalopod controls [28]. Mackal found that, compared to the controls, the monster had higher percentages of glycine and proline, and a lower percentage of glutamic acid, but noted that preservation of the samples in formaldehyde may have impacted these findings. Mackal also

determined that the amino acid composition of the supposed giant octopus tissue was similar to collagen, as in the dermis of octopi. The tissue contained lower quantities of copper and iron than controls, but its copper to iron ratio was closer to the mantle of the giant squid *Architeuthis dux* than to cetacean skin and muscle. However, biochemist Michel Raynal warned that the samples may have been contaminated by the metallic jars used for storage [42].

Mackal concluded that his results were in agreement with Gennaro's, and that the Florida Monster was once again a giant cephalopod, while Raynal cautioned that Mackal's results were also consistent with the spermaceti organ of the sperm whale, *Physeter macrocephalus* [40]. More investigations were undertaken in 1995 and 2004 by molecular biologist Sidney Pierce et al. [38, 37]. Using electron microscopy and biochemical analyses, the samples were once again identified as collagen, but from a vertebrate animal rather than a cephalopod. While octopus mantles feature small quantities of collagen in thin sheets, the Florida Monster sample, like whale blubber, featured a large matrix of collagen fiber throughout. The proline quantity in the Florida Monster tissue was higher than in octopus and squid mantle, and more consistent with whale skin. Pierce et al. also performed the same analyses on other purported monster carcasses, including the "Chilean Blob', the "Tasmanian West Coast Monster', two "Bermuda Blobs', and the "Nantucket Blob'; all were whale blubber, much to the chagrin of cephalopod hypothesis proponents who disputed these findings [29].

In 2003, DNA tests were undertaken on Florida Monster samples by Gennaro [42]. The cytochrome b gene matched 98% to the tiny fish *Cyprinodon variegatus* in GenBank; a result attributed to the sample jar having previously been used to store precisely this fish. From 2006 to 2010, further DNA tests were attempted by geneticists at the Lakehead University Paleo-DNA Laboratory [20]. From mtDNA analysis, the monster was found to fit with mammalian molecular phylogeny, grouping close to whales, while nothing resulted from a cephalopod-specific primer set. Thus, the debate seems settled on the Florida Monster as a washed-up whale.

Although the Florida Monster turned out to be no Kraken, it is widely hypothesized that many reported encounters with enormous cephalopods in antiquity, the middle ages, and through to the 19th and 20th centuries, are most probably attributable to sightings of the giant and colossal squids, *Architeuthis dux* and *Mesonychoteuthis hamiltoni* [22, 19, 45]. These massive cephalopods were only formally described for science in 1856 [10] and in 1925 [44], respectively, after centuries of speculation and debate over the identities of these sea "monsters'.

FIGURE 7.3
The giant squid *Architeuthis dux* is a truly massive cephalopod. Photo of giant squid from the Smithsonian Open Access library [50], licensed under CC0.

7.3 *Cadborosaurus* (or Caddy)

The beached remains of marine animals like the St. Augustine carcass are sometimes called "globsters" and have not only been attributed to giant octopi but also to other "sea serpents" [8]. The first serious treatise on the sea serpent in general was published in the 19$^{\text{th}}$ century by zoologist Anthonie Cornelis Oudemans [33], who tentatively described the animal from testimonial evidence as *Megophias megophias*, a pinniped with both long neck and

tail. Other naturalists of the era including Richard Owen and Charles Darwin interpreted these sightings as simple misidentifications [43]. A second treatise by Heuvelmans [16] went on to described nine distinct species of sea serpent dubbed "Heuvelmans types'.

One notable example of a supposed sea serpent is Caddy of Cadboro Bay, British Columbia, which had purportedly been observed around the southern tip of Vancouver Island [27]. In a report prepared at the Institute of Oceanography, University of British Columbia, LeBlond and Sibert [26] presented results from a survey of first-hand eyewitness reports of sea monsters from 1905 to 1969, as well as second-hand reports from 1892 to 1961. LeBlond and Sibert were unable to classify these reports according to Heuvelmans' nine types. Also presented was "ancillary" (i.e., circumstantial) evidence including carvings on a Skagit River atlatl and newspaper clippings. Reports were categorised into three distinct types of possible unknown animal, most notably a brown-coloured, long-necked animal with large eyes set laterally on a camel- or moose-shaped head. LeBlond and Sibert concluded that "[s]ufficient proof in the form of a wet furry or scaly corpse is not yet available", while Mackal hypothesised that Caddy may be an archaeocete or ancient whale [27].

In the inaugural volume of *Amphipacifica, Journal of Systematic Biology*, LeBlond returned to these findings with invertebrate zoologist Edward Bousfield (also managing director of the journal). Since publication of the previous report, LeBlond and Bousfield had obtained photographs from 1937 of a globster retrieved from a sperm whale's stomach in Naden Harbour, British Columbia, which they described as the holotype for *Cadborosaurus willsi*; the moose-headed animal from the previous report [3]. This alleged animal was placed within the class Reptilia, order Plesiosauria, with a speculative length of 15 to 20 meters, and a trunk region capable of forming vertical loops. Additional circumstantial evidence was once again presented including petroglyphs and snippets of indigenous folklore.

Associate editors of *Amphipacifica* Craig Staude and Phil Lambert recommended against publication of the *C. willsi* article, stating that while the majority of ten reviewers approved the manuscript for publication, they felt that the carcass photographs were ambiguous and the discussion of biology and phylogeny speculative [49]. A detailed critique by zoologist Aaron Bauer and functional morphologist Patrick Russell similarly raised concerns about nomenclature and biological interpretations including thermodynamics, respiration, and reproduction [1]. For example, plesiosaurs, being ectothermic and with a high surface area to volume ratio, could not adequately produce and store latent heat, and therefore most probably relied on solar energy as an external heat source [23]. The cold temperature of Caddy's presumed native waters, and the animal's supposed long and cylindrical shape, are not supportive of a reptilian classification. Also problematic is the proposed loop-forming, dorso-ventral flexion; this function is not compatible with plesiosaur coracoid plates and short, boxy bodies, and furthermore would not enable efficient locomotion.

Bauer and Russell suggested that the eyewitness testimonies provided for *C. willsi* are consistent with known pinnipeds, and that the subject of the Naden Harbour photographs is probably a decomposing basking shark, *Cetorhinus maximus*, which are common in those waters. Indeed, basking shark carcasses are known to superficially resemble plesiosaurs as they decompose and lose their jaws and gill supports, as did the pseudoplesiosaur "Scapasaurus" found on the Orkney Islands, Scotland [15].

LeBlond responded by alleging that the Bauer and Russell critique was flawed in that they contrasted *C. willsi* to long-extinct plesiosaur forms, whereas LeBlond argued that *C. willsi* is an advanced form distinct from its remote relatives [24]. This may be seen as an example of special pleading, and it presents a hypothesis that is not falsifiable in the absense of a physical type specimen.

LeBlond and Bousfield also reported on the alleged live capture and release of a young *C. willsi* specimen. This report has been criticized by Naish as misrecollection, with the most probable candidate being a bay pipefish *Syngnathus leptorhynchus*, owing to its eel-like appearance, undulatory movement, and other features [63]. In response, Bousfield and LeBlond described the pipefish suggestion as "insisting that anything described as different must be an erroneous description of something found in a book that vaguely looks like it," stressing what they described as significant differences between the eyewitness account and the pipefish [4]. Bousfield and LeBlond's response was also criticized for questionable application of Occam's razor, and for failing to acknowledge that, in the critique, a plethora of candidate species were suggested and selected based on a scoring system of similarity to the eyewitness report [62]. In 2016, LeBlond stated that he could not provide a simple answer to the question of whether Caddy exists [25]. The BCSCC continue their investigations into Caddy and related phenomena [2].

Pertinent to the reports of alleged sea monsters described above is the question of how many marine animals remain to be discovered. While paleontologist George Gaylord Simpson noted that just four new genera of cetaceans and no new genera of sirenians were discovered and named in the 20th century [47], results differ when it is species and not genera under consideration. Heuvelmans regressed the number of registered species in major groups and classes of animals on time (year of publication), showing in all classes a sigmoid discovery curve (i.e., exponential growth followed by exponential decay to an asymptote) [17]. Although Heuvelmans' analysis suggested that many cephalopods apparently remain to be discovered, the Reptilia and Mammalia discovery curves were essentially flat after the year 2000. Extrapolating Heuvelmans' curves to 2020 suggests low, single-digit rates of discovery of new species of Reptilia and Mammalia in this decade. Paxton plotted an updated cumulative species description curve for large ($>$ 2 meters) open-water marine mammals, suggesting (then) a maximum of 47–51 undiscovered species remain at a rate of approximately one discovery every five years [34, 35].

Raynal similarly estimated that there were 15 cetaceans still unknown to science [41].

Indeed, large marine mammals continue to be discovered. In 2020, researchers with the Sea Shepherd Conservation Society photographed, filmed, and recorded the vocalisations of a possible new species of beaked whale, Ziphiidae, in Mexican waters [48]. Another interesting specimen is "52 Blue", an unidentified animal (one or possibly two individuals) with the sonic signature of whales but with abnormally high-frequency vocalisations (50–52 hertz), recorded on hydrophones since 1989 but never sighted [59, 11]. 52 Blue may be deaf, malformed, a hybrid, or quite possibly a new species of baleen whale...

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8

Conclusion

As presented in the previous chapters, cryptozoology is the inquiry into generally non-parsimonious claims of the existence of animals that tend to be "monstrous" in size and/or behaviour. The question arises as to whether cryptozoological endeavours are useful to conventional zoology in aiding the discovery of hidden or unknown animals.

Philosopher of science Thomas Kuhn asserted that scientific discoveries begin as anomalies, or violations of expectations, for which scientists are not prepared [27]. Thus, failure to recognize the existence of an anomaly may prohibit scientific discovery. Joyner has argued that when Kuhn's philosophy is applied to the study of "hidden" animals, zoological sciences risk stagnation if zoologists do not investigate seemingly incredible reports, whether true, false, or somewhere in-between [24]. As an example, Joyner uses the Australian lungfish *Neoceratodus forsteri*; though known to locals, its scientific"discoverer', Gerard Krefft, initially rejected claims of its existence for at least a decade, all because the animal was considered to be as incredible as the cryptids reviewed above.

Apparent contradictions to established knowledge are not bugs, but features of science. In the words of Mayor, "the creation of paradoxical, contradictory evidence is not always perverse but potentially useful" [34]. All hypotheses put forward to explain new evidence are speculative in nature, in that they make inferences yet to be proven until tested rigorously and determined to be consistent with all available data. The hypothesis with the most and strongest evidence becomes generally accepted as the prevailing theory (at least, that is how science *should* operate). That cryptozoological hypotheses are speculative is not by itself a fatal flaw. Rather, the application of Kuhn's philosophy to cryptozoology is problematic because cryptozoological hypotheses are, by definition [17], supported only by testimonial and circumstantial evidence, and not by the kind of autoptical evidence that constitutes Kuhnian anomalies. Non-autoptical evidence often leads nowhere [25]. Critics of cryptozoology note that the adequacy of cryptozoological evidence is often insufficient for the kind of inferences cryptozoologists make. Testimonial and circumstantial data are interesting, perhaps even suggestive, and may constitute a starting place for further investigation, but alone this evidence falls short of confirming the existence of putative cryptids, especially when alternative, more parsimonious explanations seem to account for all of the same data (and often more) without making such improbable inference.

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Proponents of cryptozoology argue that other sciences have, at times, also relied upon testimonial evidence. For example, ethologists sometimes rely upon the testimony of the observer of an animal to describe its behaviour, at least when video recordings are not available [20]. Indeed, it is common in public health sciences to rely upon the analysis of health survey data, which are testimonial in nature. A counterpoint here is that authors in the latter field generally (though not always) make more parsimonious inferences from these data, and typically use data of higher quality.

Serious criticisms of cryptozoology remain. One such criticism is that many of cryptozoology's working hypotheses are "prone to a sort of Lost Valley Syndrome, in which unexplored, primitive places are thought to harbor unknown, primitive animals... behind every legendary animal one is most likely to find not a living prehistoric monster, but an imaginative human being" [1]. Indeed, some cryptozoologists have fixated on "any slight similarity between the description of a putative cryptozoon (no matter what the source and no matter how vague, or uncorroborated) and a picture in a paleontology book" [4]. Naish has called this tendency the"prehistoric survivor paradigm" [37]. Science writer Roger Lewin has lamented more generally that the biases of individual scientists can lead to "personal and perhaps capricious interpretations" [30], which are not uncommon in cryptozoology. Part of this bias for primitive animals may stem from what Mayor called a "deep regret at the disappearance of the world of dinosaurs and mammoths" [34].

The expectation (or want) of seeing a cryptid may also influence the likelihood of a "sighting". As Malcolm Smith put it, "[w]hen a house has a reputation for being haunted, every creak, bump, or shimmer takes on sinister connotations" [47]. This kind of "perceptual readiness" or "expectant attention" has been discussed elsewhere in the context of cryptozoology by skeptics Benjamin Radford and Joe Nickell [40].

Some cryptozoological conundrums stem from misunderstandings of the literature, and over-reliance on outdated science. On speculation that "wildmen" in China may represent living members of the extinct genus *Ramapithecus* (now considered a synonym of *Sivapithecus*), anthropologist Frank Poirier observed that "[w]e seem to have a case where disputed phylogenies are helping to support the existence of mysterious creatures. This is mysterious scientific methodology" [38].

Another criticism is the tendency for the cryptozoological community, usually from outside of academia, to add or take literally supernatural (and therefore unscientific) elements of cryptozoological phenomena. Greenwell himself bemoaned: "What I find troubling is lumping of all cryptozoological and paranormal animals together, forcing them into the same molds" [12]. Acorn further noted how cryptids putatively identified as prehistoric survivors have been put forward as evidence of "Young Earth" creationism, an anti-evolutionary view [2] (see also [48]). This, of course, has no place in zoology.

Heuvelmans intended cryptozoological investigation to begin with traditional ecological knowledge [19], but often times local reports only vaguely

resembling a more recent putative phenomenon are used to justify the latter post hoc. On the "Yahoo", "Yowie", and reports of hairy bipeds in Australia, biologist and anthropologist Colin Groves remarked that "few of the entries are based on Aboriginal reports, and those that are, are of a mythological nature, unappreciated by their Anglo recorders" [15]. Holmes et al. note that "whereas zoologists would distinguish between mythical and extant-but-magical, local people treat them in very similar, if not identical, ways ... The conservation literature has given inadequate treatment to the complex social and cultural context, or the ontological system, in which magical animals are situated" [22]. Some hidden animals putatively attributed to indigenous peoples may even have non-local origins. For example, the very name "Yahoo" may in fact originate from early English descriptions of the orangutan, and not in Aboriginal Australian language after all [23]. Thus, while folklore believed to be of indigenous origin may be compelling, it must be carefully analyzed for embellishment and for misrepresentation or misinterpretation.

The need to trace reports back to their origin is emphasized in the case of the pygmy gorilla "*Gorilla mayema*', a non-existent ape that began its life as a taxonomic misnomer, and through subsequent mistakes of spelling and taxonomic work, took on various different meanings before ultimately being explained by ordinary gorilla [14]. Groves went on [13]: "Let us, by all means, ask: Is there such a thing as a Yeti?; but let us not fail to ask... What animals, known to science but perhaps rarely seen even where they live, have in the past been identified as a Yeti?"

Perhaps the axiom that "myths and legends are the memory of people" [29] is not entirely wrong, but is more accurately stated that "*some* myths and legends are the memory of people". The interpretation of this axiom to mean instead that "*all* myths and legends are the memory of people" has, at times, led to bitter disappointment on behalf of the cryptozoologist. Sometimes, a myth is just a myth.

This is not to say that cryptozoology has had no success at all. The rediscovery of the giant woolly flying squirrel in 1994 [50]; the black-naped pheasant pigeon in 2022 [35], and both Attenborough's long-beaked echidna and the Vangunu giant rat in 2023 [8, 28]; the discovery of the kipunji monkey in 2003 and numerous other new ape and monkey species since 1980 [44]; all of these and more were facilitated by indirect evidence and traditional ecological knowledge including eyewitness testimony and other circumstantial evidence, just as Heuvelmans intended in his more methodological articles [17, 19, 18]. Furthermore, cryptozoologists and others whose works were published in the journal *Cryptozoology* successfully identified the Ri or Ilkai as the dugong [51], Mokele-Mbembe as a large turtle [26], and the griffin as a ceratopsian fossil [33]. The discoveries of the mountain tapir in 1829, the western and eastern gorillas in 1847 and 1901 respectively, and the "living fossil" okapi also in 1901, all similarly facilitated by folklore, "traveller's tales", and local reports, are considered by Heuvelmans (retroactively) to number among the greatest successes of cryptozoology [21, 16]. Note that cryptozoology is somewhat

disadvantaged by the fact that any cryptid described for conventional zoology leaves the realm of cryptozoology; cryptozoology only ever considers uncertain animals.

Interestingly, some "unintended" benefits have come from the pursuit of cryptozoology. For example, the systematic searches of Lake Champlain and Loch Ness have led to the discovery of multiple artefacts, including the shipwreck of the tugboat William McAllister discovered during "Project Champ Carcass" [55], and the wreck of the "Pansy" discovered during "Operation Groundtruth" [45]. Cryptozoological research has also led to the passage of animal protection laws such as the "Champ Resolution" of 1986, adopted by the Vermont Senate to protect Lake Champlain's fauna [54]; and the White River Monster Refuge and Sanctuary resolution passed by the Arkansas Senate in 1973 [31].

Even some ordinary zoological discoveries have come from cryptozoology. As described in Chapter 2, putative Yeti DNA testing revealed a previously unknown range extension of the goral. As another example, in 2022, a trail camera placed by members of the Centre for Fortean Zoology in search of the Sumatran "jungle Yeti" orang-pendek instead photographed a tiger in an area where tiger populations are not known to exist [6].

Cryptozoologists have also contributed to technological innovation in zoological equipment, for example by developing kinds of trail cameras [52] and methods in underwater photography [41, 7]. Indeed, proponents argue that cryptozoology is intended to complement, and not replace, conventional zoology [20]. The popularization of cryptozoology may also have acted as a "gateway" for some young people into pursuing "true" careers in the biological sciences, not unlike the so-called "Scully Effect" [9].

However, the failure of cryptozoology to positively identify its "poster children", such as the Yeti, Sasquatch, and Loch Ness Monster, has undoubtedly led many to disregard its methods. Indeed, Heuvelmans himself acknowledged that "cryptozoology has also had its failures" [21]. To others, these setbacks are acceptable. Mackal noted "while it is true that for every cryptozoological success there may be ten or more failures... this rate of success is no worse than in the laboratory" [32]. This "failure" may also be viewed as a rare species of success, negative evidence though it is, having separated the false from the true. Greenwell noted that while cryptozoologists are more likely to commit Type I errors (or false-positives), they are also less likely to commit Type II errors (false-negatives) [11]. Still, the primary focus of cryptozoology on what seem to be the least likely putative cryptids, namely relic dinosaurs and hominids, has done no favours for the credibility of the cryptozoological method. Rossi stated that "it is absolutely impossible to consider cryptozoology a science as long as it continues to concern itself with impossible creatures" [42], but further noted Heuvelmans' call for careful screening and evaluation of cryptozoological evidence, and indeed, the exclusion of unreliable reports. Rossi argues that the poster children of cryptozoology should have been

discarded long ago, in favour of the pursuit of more plausible "uncertain" animals [43].

In all likelihood, among other non-cryptid explanations, the Sasquatch and Yeti are probably known bears; the Loch Ness Monster is probably an amalgamation of wind and wave effects, logs, known animals, and perhaps larger eels; and alien big cats are probably the domestic variety, or else the occasional escaped pet or zoo resident. The more exciting explanations such as new species and hybrids are, at this time, highly unlikely, but perhaps warrant further consideration as new "evidence" becomes available. As Poirier put it, "[w]e do, however, continue to have open minds, even if we have little hope for the existence of such a creature" [39]. The search for hidden animals is certainly romantic, but "no one... need apologize for his or her romanticism, provided that it is accompanied by a reasoned and balanced credulity" [31].

Overall, cryptozoology has had little success in establishing the physical existence of its cryptids. Still, broadly labelling all aspects of cryptozoology as pseudoscience may not be entirely fair. Indeed, as cited in this book, many reputable biologists, zoologist, anthropologists, paleontologists, folklorists, and other researchers have engaged with cryptozoological methods, sometimes making interesting and rational discoveries. While Sasquatch is unlikely to exist as an unknown flesh-and-blood animal, this is only clear because academics and amateurs alike have approached the problem in spite of potential risks to their reputation, and not because of the incredulity of the incredulous. One commenter asked "[w]hat if there is no Champ?... Would that mean that all of the efforts of those who have searched in vain were wasted? I don't think so. It seems to me that we are all a little richer because of the dedicated people who have had the curiosity to look for something that may or may not exist" [53]. While cryptozoology has not revolutionized zoology the way that Heuvelmans had hoped for, it has done a little to aid the discovery of hidden animals, and at the same time has provided a treasure trove of information on cross-cultural anthrozoological phenomena, such as the lake monster traditions [36]. In this sense, perhaps cryptozoology is more appropriately viewed as a subfield of the humanities, rather than the zoological sciences.

Paleontologist George Gaylord Simpson attributed human gullibility to "belief" in cryptids [46], and it is fair to critique blind belief in things lacking conclusive evidence. Still, there is also something philosophical to be said about human nature that unites firmly scientific thinking with pure speculation. It is arguably the same innate sense of intrigue and urge to explore the natural world that drives interest in science and in speculation. Science communicator Stephanie Turner noted that "cryptozoological discourse can thus serve as a space in which scientific and humanistic modes of knowing intersect, demarcating some boundaries while blurring others" [49]. Like conventional zoology, cryptozoology is an attempt by humans to understand the natural world. Simpson concluded, "[i]t is evident that cryptozoology is interesting to many people, including some who reject its definitions, methods, and proclaimed results" [46].

And what if? In modelling the likelihood of persistence of small populations of large animals, biologist Peter Brussard noted that if such cryptid species do exist, they are hazardously close to becoming extinct [5]. Demographic and environmental stochasticity can push exceedingly small populations of unknown animals into exceedingly remote and constant environments, but over thousands of years, humans have continued to penetrate and erode those environments, driving thousands of species to extinction. If a cryptid had once existed undiscovered and was driven to extinction by human intervention, then unless we later discovered its fossil remains by chance, we might never know it had existed at all. On the recently-extinct birds of Madagascar, Greenwell perhaps rightly vented that if naturalists of the day had "done their scientific duty, the species, if still alive, might have been saved from extinction, and, if protected, could conceivably have survived until today" [10].

What are zoologists to make of cryptozoology? Given that cryptozoological activities have achieved some success in accelerating the discovery of a small number of new species, rediscovering some species presumed extinct, and in achieving the passage of animal protection laws, perhaps zoologists should be a little less harsh on their cryptozoologist colleagues, consider traditional ecological knowledge more seriously, and strive to remove some of the "taboo" fuelled in part by a lack of academic engagement, which has allowed cryptozoology to deviate into a paranormal subculture rather than a strictly scientific discipline. Alternatively, guided by anthropological research, scientists could endeavour to better appreciate the cultural and mythological contexts in which local peoples describe what may sound to some like unknown animals [15].

Where to for cryptozoology? Rossi believes that "the fundamental ideas forming the basis of cryptozoology are empirically demonstrable," but calls for greater scientific control in cryptozoological publications, namely greater data elaboration and refereeing, more consistent application of scientific methods, and the casting out of what Rossi calls the "symbolic animals" of cryptozoology [42]. Rossi also believes that the establishment of a new *scientific* cryptozoological society and flagship journal would help cryptozoology escape its image problem. Adams and McCorristine similarly call for a "post-monstrous" outlook for cryptozoology; one that instead focuses on more plausible undiscovered species, in collaboration with conservation scientists [3]. They remark that "[a]lthough no one expects conservation NGOs to start searching for Bigfoot, it would be remiss of them to ignore the powerful ecological imagination that can be inspired by cryptozoology" [3]. Holmes et al. conclude, "by understanding human interactions with magical animals, conservation could create successful coexistence between humans and non-humans" [22].

In the words of Heuvelmans, "draw your own conclusions" [21].

FIGURE 8.1
The author, Floe Foxon, undertaking "research" for *Folklore & Zoology* at the West Virginia Bigfoot Museum in Sutton, West Virginia.

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